Winter 1985 13 $3

DEEP SKY

A Star Cluster Issue!

Deep-Sky Objects in Auriga and Gemini
The Canis Major Clusters
How to Photograph Star Clusters

Letters to DSM

Shooting the Perseus Cluster

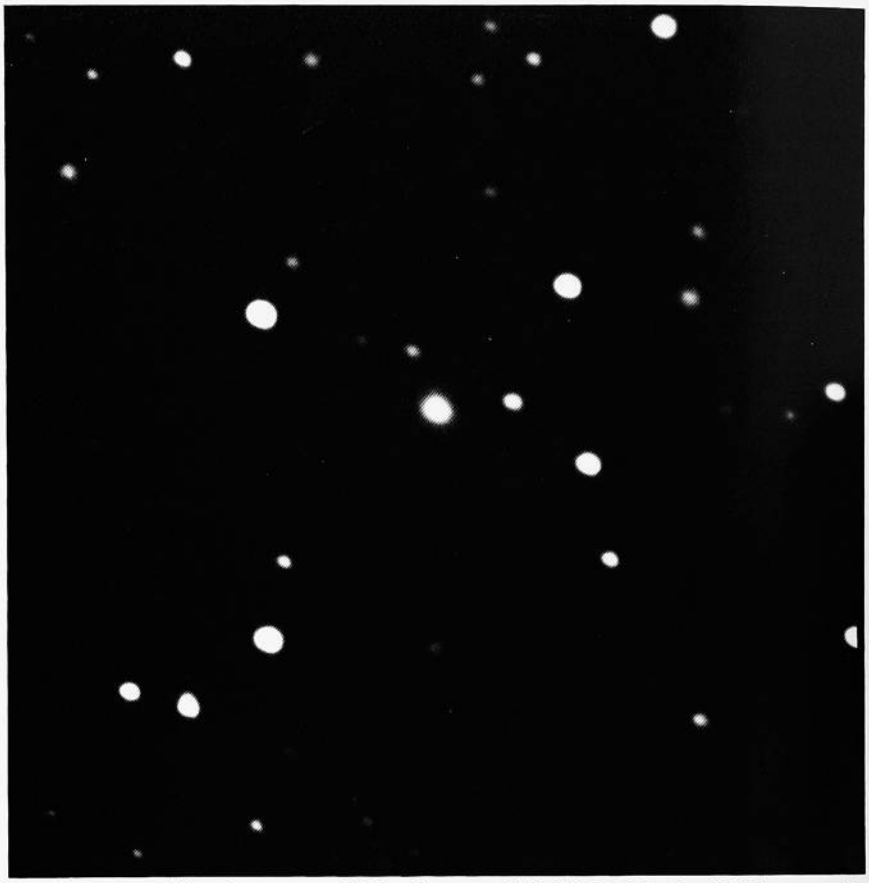
Dear Mr. Eicher / I just wanted to write and tell you how much I enjoy reading *Deep Sky*. I subscribed to it about a year ago and am sorry I didn't know about it earlier. I've been strongly interested in astronomy since I was a kid (I'm 29 now) and am an active photographer and observer. And although I photograph and observe objects within the solar system, my main love is deep space.

Enclosed is a photo I made using hypersensitized TP 2415. The fuzzy "star" in the center is NGC 1275, the active galaxy in the Perseus cluster of galaxies. Some of the faint, grainy objects scattered across the field are other members of the Perseus cluster. I made this photo last winter shortly before receiving *Deep Sky* 9, which contained your article "21 Exotic Deep-Sky Objects." I enjoyed that article a lot because many of my favorite objects were listed, including NGC 1275. I have a strong interest in remote galaxy clusters in general, and was happy to see Brian Skiff's article on Abell 1367 and 1656 in *Deep Sky* 10. I hope to see more articles on galaxy clusters in the future.

The photo of NGC 2403 by Tom Eby in *Deep Sky* 11 was very interesting. I observed this galaxy last spring and noticed its bright nucleus and a luminous extension toward one side. Mr. Eby's photo shows this extension to be a spiral arm with a higher surface brightness than the other arms. I enjoyed seeing coverage of an object in Camelopardalis, a constellation containing some neat stuff which is rarely mentioned in astronomical literature.

Keep those informative and helpful articles coming. I look forward to every issue.

Eugene Brings
Box 582
Mendocino, CA 95460



The fuzzy "star" in the center of this photograph is NGC 1275, the highly-energetic peculiar galaxy in the Perseus Cluster. NGC 1275 lies some 70 megaparsecs away. Photo by Eugene Brings.

How Not To Do It Does It

Dear Mr. Eicher / After reading David Healy's wonderful article, "Astrophotography: How *Not* To Do It!" (*DSM* #12), it seemed time to come out of the closet. The author is obviously a consummate expert and his honest confessions have renewed my spirit to try again.

I took great delight in Mr. Healy's chronicle of the tribal rituals of astrophotography. Having meticulously practiced varous nocturnal silver sensitive incantations now for more than three months (certainly enough time to become "accomplished"), I felt quite at home with his odyssey. After many sessions progressing from star trails to piggybacking, and eventually to guided-through-the-telescope astrophotography, I can only say that Mr. Healy must have been the guy who flew past me one night in his 280-Z, completely destroying over an hour of perfect guiding. I can still him laughing. Another "catch" that same night was a pair of matched comets that traversed an unusual course through several major constellations before finally landing at a nearby airport.

It is such a delight to at last discover that those of us not blessed with a 3-meter scope and dark skies have similar plights. The author's revealing account has transformed my "why only me?" dilemma to the realization that these trials are merely the tuition one pays to join the ranks of the dedicated astrophotographer. I found that our results were similar, even though our procedures differed slightly; the outcome is reminiscent of Churchill's often paraphrased comment that "never in the history of astronomy have so many done so much for so little."

What fun it is to slide into the darkroom with another batch of hopeful exposures only to find that the elusive faint fuzzy got away again. Sometimes it's like trying to catch your limit in a dry lake bed! At any rate, I have mastered star trails and piggyback astrophotography — now I am simply wondering why an 8-inch SCT photo taken in the Santa Clara Valley doesn't look like the one done at Kitt Peak. Was it only the emulsion? Please advise.

Thomas H. Parker
2142 University Avenue
Mountain View, CA 94043

Supernova Watchers Wanted

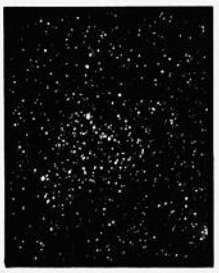
Dear Sir / I am looking for a few keen-eyed amateur astronomers who might be interested in participating in an Amateur Supernova Search Network to embark on a visual search program for extragalactic supernovae. It's necessary

DEEP SKY 13

The magazine for deep-sky observers and astrophotographers

Winter 1985
Volume 3, Number 4

Cover: M41, star cluster in Canis Major, photographed by Martin C. Germano; 8-inch f/10 SCT, 103a-F emulsion, 20-minute exposure.



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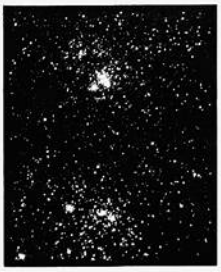

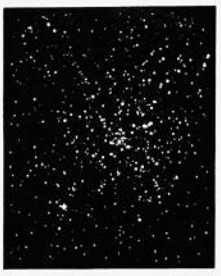

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6 Deep-Sky Objects in Auriga and Gemini

by Phil Harrington

Understandably two of the winter Milky Way's star attractions, Auriga the Charioteer and Gemini the Twins together hold some 85 bright deep-sky objects for backyard stargazers. Principally containing open star clusters — some of which are intermixed with faint nebulae — these two bright groups of stars also hold variable stars, planetaries, double stars, and surprisingly a number of reasonably bright galaxies. Complete data for all 85 objects appear in a table on page 10.

16 Photographing Winter's Star Clusters

by Robert Burnham

Deep-sky photography is a rather intimidating hobby: because the objects are faint, exposures must be long, which opens up all sorts of possible problems that can ruin a photograph. However, one type of deep-sky object — the star cluster — isn't faint and fuzzy; it's generally bright enough (or its constituent stars are bright enough) to allow for relatively short exposures that will turn out just wonderful. In this article, Senior Editor Robert Burnham tells how to successfully record on film the sky's many star clusters.

24 Canis Major and Its Brilliant Star Clusters

by Jim Barclay, Steve Coe, A.J. Crayon, and Dave Fredericksen

Although it never rises high in the sky for North American observers, Canis Major the Large Dog is a constellation containing a multitude of bright open star clusters — 26 in all. Besides M41, NGC 2362, Collinder 121, Collinder 140, and the 22 other clusters, Canis Major also contains the brightest star in the sky, a nearby white dwarf, several variables, and a handful of small galaxies. This article is written by a group of observers from Arizona and Australia, and contains complete data for 47 objects in Canis Major in a table on page 28.

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to rely on a few dedicated amateurs to monitor such things, as professionals are busy with routine research. The purpose of our group is to start keeping valuable records on a number of galaxies so that supernovae can be spotted early.

If you are interested in teaming up to monitor galaxies for these exploding stars, please contact me for further information.

Steve H. Lucas
3736 West 169th Street
Country Club Hills, IL 60477

How to Find the Perfect Site

Dear Sir / Amateur astronomers are constantly looking for the "perfect" observing site. We believe we have found one and would like to tell you how to find your very own. We discovered this site one night at about 9 p.m.; the seeing was terrific. According to our notes, the sky was so good that:

- We needed a neutral density filter to observe M51.
- The central star in the Ring Nebula was occasionally glimpsed with averted vision using an Astroscan.
- Stephan's Quintet cast a shadow on the ground below.
- The Pelican Nebula was painfully bright.
- The Cone Nebula appeared faint, but was certainly present in binoculars.

Unfortunately, our session was cut short at 2 a.m. when Jupiter rose and created an unacceptable level of skyglow. It's a great site, but we'd like to keep it secret lest it becomes light polluted from red flashlights.

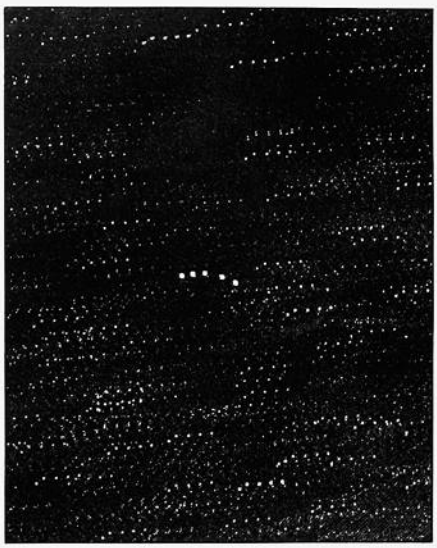
Margie Melanson and Michael Kitt
Rockland Astronomy Club
99 Bronxville Road
Bronxville, NY 10708

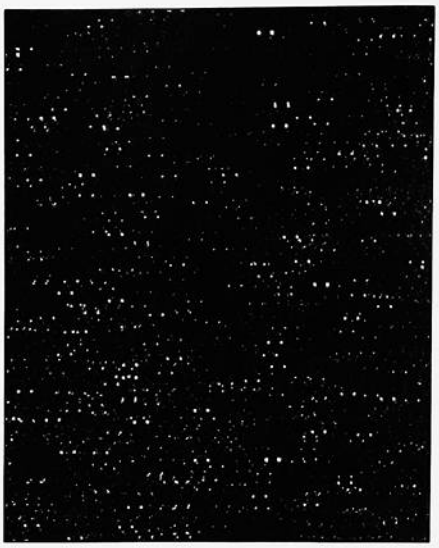
Hey, SS-433 Isn't in Virgo!

Dear Dave / I received *Deep Sky* 11 today, read my letter about SS-433, and realized I had given the wrong right ascension of the wide double star I use to locate SS-433. The right ascension should have been: 19h 11.5m, not 12h 08m. If that didn't confuse readers, then your substitution of "SS-433" instead of "it" (referring to the asterism) in talking about the asterism must have confused them. Sorry for the error.

Bert Froehly
RR 2 Box 125
Vandalia, IL 62471

Dear Bert / . . . and my apologies for assuming that "it" meant SS-433 rather than the diamond-shaped asterism. I now suggest that readers look back to the letters column in Deep Sky 10, *where Alexander Brownlee's photo should straighten out the entire situation. — DJE*





A Flare Star Caught?

Dear Dave / A few discussions have appeared recently about "flare stars," which supposedly blink on and off rapidly and periodically and can be very bright. I enclose two photographs — portions of two 4″ x 5″ plates — which may give solid evidence for their existence.

In setting up a new 3-inch f/4 lens for astrophotography, I made a series of six 5-minute exposures, changing the focus each time, to determine the best focus and see if the lens had a flat field. One star-like object produced a different pattern than the background stars as the plate was moved around. It left only five images instead of six. As the object seemed to be moving south at about the same distance that I offset the other images, the last image may be superimposed.

I rephotographed the area the following night, this time displacing to the south but still keeping the original location of the object at the edge of the field. Two exposures of 10 minutes were made, with a 10-minute wait between them. An exhaustive search of the plate turned up nothing. I dismissed the incident as a missed opportunity to discover a comet, but on reading about unusual sightings of flare stars, I felt this might be added to the list.

Alfred Lilge
General Delivery
Palomar Mountain, CA 92060

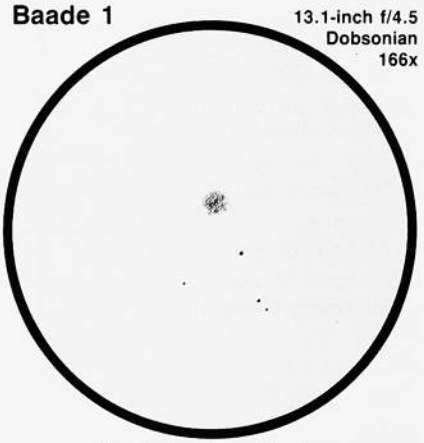
Observing Baade 1

Dear Dave / In *Deep Sky* 11, Chris Schur asked about observing the planetary nebula Baade 1 in Taurus. This is a very faint planetary and extremely difficult to see visually. I first observed it on November 23, 1984, using a 24-inch f/15 telescope and a UHC filter from Mauna Kea, Hawaii. It was faint, round, and slightly brighter in the middle. I observed it again on January 19, 1985, using a 17.5-inch f/4.5 telescope and noted it was very faint, about 15.5 magnitude, and best seen at 80x with an OIII filter — at the visual limit of the telescope when using a UHC filter.

Jack B. Marling
Lumicon, Inc.
2111 Research Drive
Livermore, CA 94550

Dear Dave / My first attempt to find Baade 1 was a failure — surprising because the larger planetaries plotted on *Sky Atlas 2000.0*, of which Baade 1 is one, never presented a problem for my 13.1-inch f/4.5 Dobsonian. Having realized this is an exceedingly faint planetary, I knew I had to pinpoint the nebula's precise location to successfully find it.

I tried again under a dark sky on January 18, 1985, from Fremont Peak,



Sketch by Steve Gottlieb

California. This time I started my search from the 6th magnitude star 14 Tauri. After offsetting 12′ south and drifting for 9.7 minutes, the elusive Baade 1 was visible, centered in the 166x field of view. Visually, the planetary appeared as a round, fairly small dim spot requiring averted vision to glimpse. With a UHC filter, it appeared like a small 15th magnitude galaxy but with a totally

flat brightness profile — it was uniformly lit. As a locator, a right triangle of stars lies several arcminutes east of Baade 1 and the triangle's eastern vertex is a double star.

Steve Gottlieb
155 San Carlos
El Cerrito, CA 94530

Picking Off Stuff in Cygnus

Dear Mr. Eicher / I've been observing deep-sky objects for almost two years now and have found *Deep Sky* to be indispensable for viewing. I've especially enjoyed Phil Harrington's articles on Cygnus (*DSM* #7), and Sagitta and environs (*DSM* #11).

Recently, I observed Cygnus under very good conditions with my 8-inch SCT. The supernova remnant NGC 6888 was easily spotted as an arc of light faintly visible, tailing off to the south near a double star. IC 4996, which Mr. Harrington saw as a sparse cluster, appeared to me to be extremely rich. The cluster is centered on a triple star and seemed elongated north-south. Observing a few days later under a less favorable sky showed virtually nothing of the nebulous glow surrounding IC 4996 that I'd seen before. The Veil Nebula was splendid; NGC 6992-5 showed some detail including a dark patch on the southern portion. Taking advantage of the sky, I tried to find IC 5146, the Cocoon Nebula. I easily found the diamond-shaped group of stars nearby — there seemed to be a mist around these stars, but it appeared exceedingly faint. I couldn't be sure.

I concluded the session by picking off a few of the planetaries and globulars described in *DSM* #11, specifically NGC 7006, NGC 6934, NGC 6891 — which was obviously nonstellar at 77x — NGC 6905, and NGC 6886. To top off the evening, I found Comet Giacobini-Zinner in southern Lacerta using coordinates from *Sky and Telescope*.

I have one question: What is going on with IC 1298 in Scutum? *Burnham's Celestial Handbook* calls it IC 1298, while Webb's *Cycle of Celestial Objects* calls it IC 1295 and gives slightly different positional data. Are there two planetaries in Scutum 1′ apart, or is there some confusion over the identity of a single planetary? The article on planetaries in *DSM* #6 went along with Webb, calling it IC 1295 and giving the same position. What's going on here?

John Vinopal
Box 1508
El Granada, CA 94018

Dear Mr. Vinopal / Thanks for your letter — you certainly had a grand time gazing through Cygnus and Sagitta this summer. You're among a very small group of people aware of some mystery concerning "IC 1298 in Scutum." Actually both Burnham's Celestial Handbook *and* Sky Atlas 2000.0 *mislabel IC 1295 as IC 1298 — Webb's* Celestial Objects for Common Telescopes *and* Deep Sky *6 were both correct. It is IC 1295 which lies in Scutum, at 18h54.6m −8°50′ (2000 coordinates). IC 1298 is really a tiny open cluster in Aquila, at 19h18.5m −1°37′ (2000).*

On M57's Elusive Central Star

Dear Sir / As a so-called amateur astronomer, I'm a bit amused by all of this fuss over the visibility of M57's bluish central star. I've rarely observed M57 except for scanning over it by accident with my 8-inch RFT, and even then I didn't at first know what it was. I, for one, have *never* seen the Ring Nebula's central star.

This makes for a fine start on a discourse about the discrepancy between observers either spotting the central star or not spotting it. We've heard tales of professionals using 40-inch telescopes not being able to see it, and amateurs with 5-inch refractors at 500x picking it out easily. Possible explanations usually seem to be that the star is variable or the nebulosity makes it difficult to see or the seeing conditions greatly affect the outcome.

Yet there are other possibilities. How about the condition of the observer's eyes? Are some people much more sensitive to blue light than others? Could stress or the food consumed before observing significantly affect the eyes? Age is certainly somewhat of a factor. I think we too often dwell on the variables assigned to the nebula, rather than the observer. Who knows, maybe the observer on the 40-inch telescope simply needed a good pair of contact lenses!

Ron Paul Smith
Box 124
Sharon, MA 02067

Inside View

Unsexy Star Cluster

Back in Ohio during my first couple of years as an observer, we had a reason explaining why no one ever likes to observe star clusters. "They're unsexy!," we'd say. "Galaxies and nebulae are much more fun — they come in varied shapes and sizes, they're nebulous and intricate, spiral or diffuse, and there are plenty of 'em scattered across the whole sky!"

Clusters — especially open clusters — on the other hand, all looked pretty much the same. (We generally exempted globulars from this discrimination because, after all, globulars appeared fuzzy in small telescopes.) When you looked at an open cluster, you'd see a group of scattered bright stars, usually without much color, spread across the field. Who wants to look at just a field full of stars? Big deal!

Not being sexist, however, I've come to be an avid observer of open star clusters. Some of my favorites are NGC 457, the Double Cluster, M41, NGC 7789, the Trapezium, NGC 6520, M11, and several dozen others. I've come to realize that indeed all open clusters do *not* look alike — each is unique and interesting for its own reasons. Many are bright enough to be seen in binoculars and finderscopes, and consequently bright enough to observe when the Moon is overpowering subtle nebulae with photons.

This issue contains material slanted toward open clusters — observing Gemini's and Auriga's in the northern Milky Way and Canis Major's toward the south, and photographing winter's best groups of stars. I hope you'll see enough star clusters this winter to get a taste of their differences.

Along with the usual departments, *Deep Sky* 13 also includes the first of a three-part series on plotting objects in the RNGC by Richard Berry. The map on pages 32 and 33 should give you a whole new perspective on the "standard" catalogue of deep-sky objects.

A final note: this issue arrived at the printer a bit late because of general chaos at AstroMedia due to Halley's Comet. My work on the comet for ASTRONOMY, as well as correspondence, photography, observing, phone calls, writing, etc. has kept me from devoting much time to *Deep Sky*. Things should be back to normal by the next issue.

Yours Truly,

Dave Eicher
Editor

DEEP SKY OBJECTS IN AURIGA & GEMINI

by Phil Harrington

Auriga the Charioteer and Gemini the Twins are constellations rich in star clusters and wispy, intricate bright nebulae. Here, amid the tangle in central Auriga, are the star cluster/nebula NGC 1893/IC 410 (center), the bright fan-shaped nebula IC 405 surrounding the erratic variable AE Aurigae (top right), and the faint nebula IC 417 (top left). Photo by Robert Reeves using a 300mm f/1.5 lens.

With visions of Halley's Comet dancing in our heads, many of us will overlook the rest of the winter sky this year. Halley will no doubt dominate our observing programs over the next few months, but it's always nice to break away for a while, just to make sure that the rest of the universe is still around!

As winter approaches, I look forward to the annual appearance of Capella rising above the treetops. This is the first of the brilliant "Winter 8" stars to appear from northern latitudes. Its host constellation, Auriga, contains many open clusters, including three members of the Messier catalogue.

Messier 37 (NGC 2099) is a stunning sight in any telescope. Since its discovery in 1764 by Charles Messier, many observers have commented on its beauty. The Reverend T.W. Webb said of M37, "it is extremely beautiful, one of the finest in its class." Another famed English observer, Admiral Smyth, painted a wondrous view: "the whole field being strewn as it were with sparkling gold dust."

Over 500 stars belong to M37, with about 175 brighter than 13th magnitude. They swarm together in a tight, condensed group whose total magnitude is 5.6. Telescopes in the 6 to 8-inch class reveal the soft glow of fainter members, while larger instruments resolve more individual points. At a calculated distance of 1.4 kiloparsecs, its apparent diameter of nearly half a degree corresponds to 9.8 parsecs.

Contrast this with nearby **M36** (NGC 1960). Lying over 1.3 kiloparsecs away, M36 is just as bright as M37 — yet M36 contains only a fraction as many stars. Due to M36's comparatively young age, it is littered with dazzling type B stars. Viewing with a wide-field eyepiece will cause the cluster stars to appear three-dimensionally suspended against a field of fainter background stars. Be sure not to miss the double star Σ737, just south of the cluster's center.

From M36, nudge your telescope about 2° northwest — **M38** (NGC 1912) will come into view. Both M38 and M36

Above: One of the most cluttered areas in the northern Milky Way lies in the vicinity of star clusters M36 (bottom right) and M38 (top left). Also visible in this photo, which has north at left, are the condensed open cluster NGC 1907 (to the upper right of M38) and the diminutive emission nebula NGC 1931 (fuzzy "star" at upper right). Photo by Brian Skiff using Lowell Observatory's 13-inch "Pluto camera." Lowell Observatory photo. *Right*: Open cluster NGC 1664 contains several dozen stars in an area spanning 18′. Photo by Lee C. Coombs; 10-inch f/5 Newtonian, 103a-O emulsion, 10-minute exposure.

were discovered by LeGentil in 1749. Although half a magnitude fainter than its two neighbors, M38 offers an impressive sight in small telescopes and binoculars. When I first viewed it with a 4-inch reflector some 16 years ago, I noted the member stars fell into a pattern resembling a cross. This is also the description found in volume 3 of the Webb Society's *Deep Sky Observer's Handbook*. Others have noted a similarity to the Greek letter π, as mentioned in Robert Burnham Jr.'s *Celestial Handbook*. Do you see a pattern in the stars of M38?

Less than a degree south of M38 is the smaller cluster **NGC 1907**. My 8-inch f/7 reflector reveals a dozen points of light set within the soft glow of unresolved stars. NGC 1907 measures 7′ across and contains 30 stars; it is visible in a 3-inch scope as a tiny fuzzy patch, and larger scopes show it as an impressive gathering of colorful points of light.

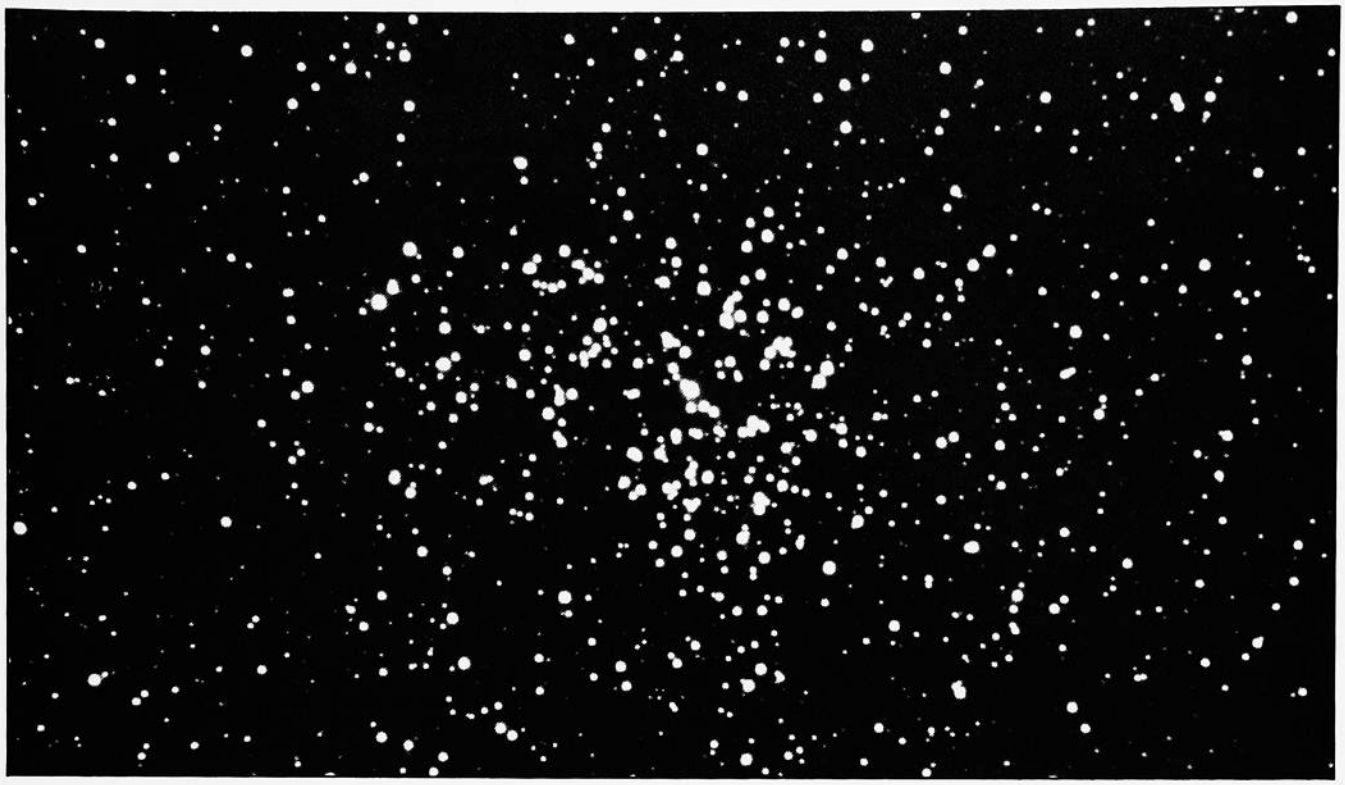
Have you ever seen **IC 417**, the huge emission nebula south of NGC 1907? If so, we'd like to hear from you, since this 13′ x 10′ patch of low surface brightness gas is exceedingly faint. An easier emission nebula is **NGC 1931**, which appears as a 3′ diameter glow with several stars involved. Its near circular shape might lead some to mistakenly identify it as an odd-shaped planetary nebula.

A bright yet frequently ignored open cluster is **NGC 1893**. When viewed with low power, the 25 to 30 brightest stars form an inverted "Y" shape. You may notice a dim, encircling haze, which is the emission nebulosity **IC 410**. Tirion's *Sky Atlas 2000* shows the nebula extending beyond the cluster limits, but I saw only the brightest part, well within the cluster's limits.

For fans of low surface brightness objects, the emission nebula **IC 405** — engulfing variable star AE Aurigae — is a fine challenge. It measures 18′ x 30′ across and is nicknamed the "Flaming Star Nebula." Studies indicate that the star and nebula are unrelated in origin, and only happen to be passing by each other at the moment. Both are receding from the Earth, with **AE Aurigae** moving about three times faster than the nebula.

Incidently, AE Aurigae, which usually shines at 6th magnitude, seems to be an escapee from the Orion Nebula complex. If its current space velocity of 80 miles per second has remained relatively constant, it fled the M42 area about 2.7 million years ago. What caused the star to scurry off at such a high speed? The star may have been a rapidly-revolving companion to a star which exploded as a supernova. The explosion would disrupt the system, sending AE Aurigae on its way. Two other such runaway stars from Orion are 53 Arietis and Mu (μ) Columbae.

Sharp-eyed observers may be able to spot star cluster **NGC 1778** in their finder scopes, as it glows at magnitude 7.7. A small telescope displays about 20 stars of magnitude 9 and fainter in a 7′ diameter. Fifth-magnitude Lambda (λ) Aurigae is a good point to start your search for the open cluster **NGC 1857**. This cluster shines at 7th magnitude and contains 40 stars, but only a dozen or so bright ones. Published reports



Above: The finest cluster in Auriga, M37 is known as a breathtaking sight in any telescope. It is bright, triangular-shaped, and holds 150 stars in a 24′ diameter. Photo by David Healy; 14-inch f/6 SCT, hypered TP 2415 film, 25-minute exposure. *Left*: NGC 1778 is another of Auriga's bright clusters — this one shines at magnitude 7.7 and contains 25 stars of 10th magnitude and fainter. Photo by Lee C. Coombs; 10-inch f/5 Newtonian, 103a-O emulsion, 10-minute exposure.

claim that NGC 1857 is a rich cluster, but I found it to be rather poorly concentrated.

Along the border shared with Perseus is **NGC 1664**. A 7th magnitude star to the south highlights an open cluster full of fainter stars. Some three dozen suns are seen in a 10-inch at low power, with many doubles among them. Shining at magnitude 8.5, I was just able to make out the group in a 10x50 finder using averted vision.

Less than a degree west of Pi (π) Aurigae is the only bright planetary nebula within Auriga. **IC 2149** shines at 10th magnitude, making its 15″ x 10″ disk fairly easy to spot in an 8-inch scope. I was unable to see its central star in the same scope last winter, even at over 200x. This is mystifying, since the star reportedly shines at photographic magnitude 11.6. The other Auriga planetary, **Perek-Kohoutek 167-0.1**, is omitted from most catalogues and, at photographic magnitude 16.6, its visibility is limited to the very largest backyard instruments.

Although not a spectacular cluster, **NGC 1883** is easy to locate since it lies about 1½° northeast of Capella. This is a small, ill-defined clump of a dozen stars of 14th magnitude and fainter just 2.5′ across. It is best left for one of those cold, crisp, near-perfect nights of winter.

Scanning 5° due north of Beta (β) Aurigae leads us to the open cluster **NGC 2126**. It lies just west of a 6th-magnitude star, which is handy when star hopping! The cluster itself consists of a dozen scattered stars of 14th magnitude. By continuing our scan to 35 Camelopardalis, and then moving east a degree, **NGC 2165** will come into view. Unplotted on the Tirion *Atlas*, NGC 2165 is listed as a class 7 (nonexistent) open cluster by Sulentic and Tifft in the *Revised New General Catalogue*. Many class 7 clusters actually do exist, but are overwhelmed and therefore unidentifiable on the *Palomar Sky Survey* charts, which Sulentic and Tifft used to check objects for the *RNGC*. Using a 6-inch, observer Patrick Brennan of the Webb Society saw NGC 2165 as "coarse, but bright; an irregularly-shaped group of about 6′ diameter; 15 stars of 10 magnitude and below." Not stunning, but a nice addition to your open clusters list.

For double star fans, **Theta** (θ) **Aurigae** presents a nice view. The primary component shines pure white (spectral type B) at magnitude 2.6, while the slightly yellowish companion (type G) glows at 7th magnitude. With a position angle of 320° and a separation of 3″, resolving the pair is easy in 3-inch and larger telescopes.

NGC 2192, another open cluster, can be found directly adjacent to a triangular asterism of six 7th-magnitude stars. Good transparency is a must, since this cluster is easy to pass over. In my 8-inch scope only 15 member stars were resolvable, all surrounded by the nebulous glow of fainter stars. Many unrelated field stars tend to mask the cluster's identity.

Our final stop in Auriga is open cluster **NGC 2281**. Even binoculars show this magnitude 5.4 swarm. Over two dozen stellar members, some as bright as 7th magnitude, are loosely sprinkled across a 15′ diameter in a semicircular pattern.

Deep Sky Objects in Auriga and Gemini

Object	Type	R.A.(2000)Dec.	Con.	Mag.	Mag★	N★	Size/Sep./Per.	P.A.	Distance	Diameter
NGC 1664	⊙	4h51.1m +43°42′	Aur	7.6	10.6	—	18′	—	1.2 kpc	6.2 pc
van den Bergh 31	□R	4h55.7m +30°33′	Aur	—	6.8v	—	9′	—	—	—
Czernik 19	⊙	4h57.0m +28°47′	Aur	—	—	50	18′	—	—	—
Epsilon (ε) Aurigae	EV	5h02.0m +43°49′	Aur	2.9↔3.8	—	—	9892d	—	1.0 kpc	30 A.U.
Zeta (ζ) Aurigae	EV	5h02.5m +41°05′	Aur	3.7↔4.0	—	—	972d	—	300 pc	5.4 A.U.
Dolidze 15	⊙	5h04.5m +34°50′	Aur	—	—	—	18′	—	—	—
PK 167-0.1	■	5h06.6m +39°08′	Aur	16.6p	19.6p	—	60″	—	—	—
NGC 1778	⊙	5h08.1m +37°03′	Aur	7.7	10.1	25	7′	—	1.4 kpc	2.8 pc
Dolidze 16	⊙	5h14.6m +32°43′	Aur	—	—	10	12′	—	—	—
IC 405	□ER	5h16.2m +34°16′	Aur	—	6.0v	—	30′x19′	—	500 pc	4.3 pc
AE Aurigae	IV	5h16.3m +34°19′	Aur	5.8↔6.1	—	—	Irr	—	500 pc	—
Alpha (α) Aurigae	★²	5h16.7m +46°00′	Aur	0.1,11.7	—	—	723.3″	141°	13.8 pc	0.8 A.U.
Sharpless 2-223	□E	5h17.2m +42°12′	Aur	—	—	—	70′x10′	—	—	—
UGC 3273	Sm	5h17.7m +53°33′	Aur	14.0_B	—	—	6.9′x2.2′	—	9.8 Mpc	20 kpc
Czernik 20	⊙	5h20.1m +39°28′	Aur	—	—	12	18′	—	—	—
NGC 1857	⊙	5h20.2m +39°21′	Aur	7.0	7.4	40	6′	—	1.9 kpc	3.3 pc
Berkeley 17	⊙	5h20.6m +30°36′	Aur	—	16p	100	14′	—	—	—
Berkeley 18	⊙	5h22.2m +45°24′	Aur	—	16p	300	20′	—	—	—
Collinder 62	⊙	5h22.5m +41°00′	Aur	4.2p	—	—	28′	—	—	—
IC 410	□E	5h22.6m +33°31′	Aur	—	—	—	40′x30′	—	—	—
NGC 1893	⊙	5h22.7m +33°24′	Aur	7.5	9.3	60	11′	—	4.0 kpc	12.7 pc
King 22	⊙	5h22.9m +45°28′	Aur	—	15p	—	14′	—	—	—
Berkeley 19	⊙	5h24.1m +29°36′	Aur	11.4	14.7	40	7′	—	4.0 kpc	8.1 pc
Dolidze 18	⊙	5h24.1m +33°18′	Aur	—	—	15	12′	—	—	—
Berkeley 70	⊙	5h25.7m +41°54′	Aur	—	15p	40	12′	—	—	—
NGC 1883	⊙	5h25.9m +46°33′	Aur	12.0p	14p	30	2.5′	—	—	—
Sharpless 2-224	□E	5h27.3m +42°59′	Aur	—	—	—	20′x3′	—	—	—
Stock 8	⊙	5h27.7m +34°25′	Aur	—	9p	40	5′	—	—	—
NGC 1907	⊙	5h28.0m +35°19′	Aur	8.2	11.3	30	7′	—	1.4 kpc	2.9 pc
IC 417	□E	5h28.1m +34°26′	Aur	—	—	—	13′x10′	—	—	—
Dolidze 20	⊙	5h28.6m +33°47′	Aur	—	—	10	12′	—	—	—
M38 (NGC 1912)	⊙	5h28.7m +35°50′	Aur	6.4	9.5	100	21′	—	1.3 kpc	7.9 pc
NGC 1931	□ER	5h31.4m +34°15′	Aur	—	—	—	3′	—	—	—
T Aurigae	N	5h32.0m +30°27′	Aur	4.1↔15.5	—	—	—	—	1.3 kpc	—
M36 (NGC 1960)	⊙	5h36.1m +34°08′	Aur	6.0	8.9	60	12′	—	1.3 kpc	4.5 pc
Stock 10	⊙	5h39.0m +37°56′	Aur	—	—	15	25′	—	—	—
Sharpless 2-231	□E	5h39.4m +35°56′	Aur	—	—	—	10′x5′	—	—	—
Sharpless 2-235	□E	5h41.1m +35°52′	Aur	—	—	—	10′	—	—	—
Basel 4	⊙	5h48.5m +30°13′	Aur	9.1	12.2	15	8′	—	5.9 kpc	13.7 pc
King 8	⊙	5h49.4m +33°38′	Aur	11.2	13.5	30	8′	—	4.2 kpc	9.8 pc
M37 (NGC 2099)	⊙	5h52.4m +32°33′	Aur	5.6	9.2	150	24′	—	1.4 kpc	9.8 pc
IC 2149	■	5h56.3m +46°07′	Aur	11.2p	11.6p	—	8″	—	1.0 kpc	0.04 pc
Theta (θ) Aurigae	★²	5h59.7m +37°13′	Aur	2.6,7.1	—	—	3.6″	313°	33.7 pc	110 A.U.
NGC 2129	⊙	6h01.0m +23°18′	Gem	6.7	7.4	40	7′	—	2.0 kpc	4.1 pc
NGC 2126	⊙	6h03.0m +49°54′	Aur	10.2p	13p	40	6′	—	1.4 kpc	2.5 pc
Sharpless 2-241	□ER	6h04.1m +30°15′	Aur	—	—	—	10′	—	—	—
IC 2157	⊙	6h05.0m +24°00′	Gem	8.4	11.1	20	7′	—	2.0 kpc	4.1 pc
NGC 2158	⊙	6h07.5m +24°06′	Gem	8.6	12.4	—	5′	—	4.9 kpc	7.1 pc
Sharpless 2-247	□E	6h08.5m +21°37′	Gem	—	7.7	—	10′x10′	—	—	—
M35 (NGC 2168)	⊙	6h08.9m +24°20′	Gem	5.1	8.2	200	28′	—	0.9 kpc	7.3 pc
Eta (η) Geminorum	SRV	6h14.9m +22°30′	Gem	3.2↔3.9	—	—	232d	—	60 pc	—
NGC 2192	⊙	6h15.2m +39°51′	Aur	10.9p	14p	45	6′	—	—	—
IC 443	SNR	6h16.9m +22°47′	Gem	—	8.8	—	50′x40′	—	—	—
Collinder 89	⊙	6h18.0m +23°38′	Gem	5.7p	—	15	35′	—	1.3 kpc	13.2 pc
IC 444	□R	6h20.4m +23°16′	Gem	—	7.5	—	8′x4′	—	—	—
Bochum 1	⊙	6h25.5m +19°46′	Gem	7.9	8.4	—	—	—	—	—
PK 194+2.1	■	6h25.9m +17°47′	Gem	12.4p	16.3p	—	8″	—	2.3 kpc	0.09 pc
RT Aurigae	CV	6h28.6m +30°30′	Aur	5.0↔5.8	—	—	3.73d	—	500 pc	—
UGC 3475	Sm	6h30.5m +39°23′	Aur	14.2_B	—	—	3.9′x2.2′	—	6.8 Mpc	7.7 kpc
NGC 2266	⊙	6h43.2m +26°58′	Gem	9.5p	11p	50	7′	—	3.4 kpc	6.9 pc
NGC 2281	⊙	6h49.3m +41°04′	Aur	5.4	7.3	30	15′	—	0.5 kpc	2.2 pc
NGC 2290	(R)SA0/a:	6h51.0m +33°26′	Gem	14.6p	—	—	1.5′x0.9′	—	—	—
NGC 2291	SA0/a:	6h51.0m +33°32′	Gem	15.5:p	—	—	1.3′x1.3′	—	—	—
NGC 2294	E6?	6h51.2m +33°32′	Gem	15:p	—	—	1.1′x0.4′	—	70 Mpc	20 kpc
UGC 3587	S	6h53.8m +19°18′	Gem	13.4	—	—	6.3′x2.3′	—	15.6 Mpc	30 kpc
NGC 2304	⊙	6h55.0m +18°01′	Gem	10.0p	—	30	5′	—	—	—
Zeta (ζ) Geminorum	CV	7h04.1m +20°34′	Gem	3.7↔4.2	—	—	10.2d	—	450 pc	—
NGC 2331	⊙	7h07.2m +27°21′	Gem	8.5p	9p	30	18′	—	—	—
UGC 3691	Sc	7h08.0m +15°10′	Gem	13.2	—	—	4.2′x2.0′	—	15.6 Mpc	20 kpc
NGC 2339	SAB(rs)bc	7h08.3m +18°47′	Gem	11.6	—	—	2.8′x2.1′	—	30 Mpc	25 kpc
NGC 2341	pec	7h09.3m +20°35′	Gem	13.7p	—	—	1.1′x1.0′	—	70 Mpc	20 kpc
NGC 2342	Spec	7h09.4m +20°38′	Gem	12.6p	—	—	1.6′x1.5′	—	70 Mpc	30 kpc
NGC 2355	⊙	7h16.9m +13°47′	Gem	9.7p	13p	40	9′	—	—	—
NGC 2357	Sc	7h17.6m +23°22′	Gem	13.9	—	—	4.5′x0.8′	—	30 Mpc	40 kpc
Delta (δ) Geminorum	★²	7h20.1m +21°59′	Gem	3.5,8.2	—	—	6.3″	218°	16.3 pc	95 A.U.
UGC 3808	SBd	7h21.1m +25°09′	Gem	14.5	—	—	2.4′x1.2′	—	30 Mpc	20 kpc
NGC 2371-2	■	7h25.6m +29°29′	Gem	13.0p	15.5p	—	55″	—	1.2 kpc	0.3 pc
NGC 2379	SA0:	7h27.4m +33°49′	Gem	13.5	—	—	1.1′x1.1′	—	55 Mpc	20 kpc
NGC 2389	SAB(rs)c	7h29.1m +33°51′	Gem	12.8	—	—	2.1′x1.7′	—	50 Mpc	30 kpc
NGC 2392	■	7h29.2m +20°55′	Gem	9.9p	10.5p	—	13″	—	0.9 kpc	0.06 pc
Alpha (α) Geminorum	★²	7h34.6m +31°53′	Gem	1.9,2.9	—	—	1.8″	140°	13.8 pc	90 A.U.
NGC 2420	⊙	7h38.5m +21°34′	Gem	8.3	11.6	100	10′	—	2.5 kpc	7.3 pc
UGC 3974	Ir^-	7h41.9m +16°48′	Gem	13.3	—	—	5.0′x3.9′	—	2.0 Mpc	2.9 kpc
U Geminorum	IV	7h55.1m +22°00′	Gem	8.2↔14.9	—	—	Irr	—	90 pc	—
NGC 2487	SB(r)b	7h58.3m +25°08′	Gem	14.0p	—	—	2.8′x2.3′	—	65 Mpc	50 kpc

Column 1: object name in *Revised New General Catalogue*, by J. Sulentic and W. Tifft, University of Arizona Press, 1973; *Index Catalogue*, by J.L.E. Dreyer, Royal Astronomical Society of London, 1971; and additional lists. **Column 2:** object type: ★² = double star; SRV = semiregular variable; EV = eclipsing variable; CV = Cepheid variable; IV = irregular variable; N = nova; ⊙ = open cluster; ■ = planetary nebula; □E = emission nebula; □R = reflection nebula; revised Hubble type given for galaxies. **Column 3:** coordinates for epoch 2000.0. **Column 4:** total V magnitude unless subscript p (photographic) or B (blue). **Column 5:** magnitude of central star or brightest cluster member. **Column 6:** number of stars in cluster. **Column 7:** size in arcseconds or arcminutes, separation of double star in arcseconds, or period of variable star in days. **Column 8:** position angle for double stars. **Column 9:** distance in parsecs, kiloparsecs, or megaparsecs. **Column 10:** diameter in parsecs or kiloparsecs. Data for stars from *Yale Catalogue of Bright Stars*, 4th ed., by D. Hoffleit, Yale University Press, 1982. Data for open clusters from B. Skiff, Lowell Observatory, 1983. Data for galaxies from *Second Reference Catalogue of Bright Galaxies*, by G. de Vaucouleurs, A. de Vaucouleurs, and H. Corwin, University of Texas Press, 1976. Compiled by D. Eicher.

Above: M35 (left), the best cluster in Gemini and one of the brightest such groups in the northern sky, covers the same amount of sky as the Full Moon and shines with the light of a 5th magnitude star. In the same low-power field in NGC 2158 (right), a rich open cluster over 5 times more distant than M35. In small telescopes NGC 2158 appears as a hazy, unresolved blob of light. Photo by Al Lilge; 12.5-inch f/8 Ritchey-Chretien reflector, 098-04 film, 60-minute exposure. *Left*: One of Auriga's triad of Messier clusters is M36, shown here in a plate made in 1917 by Carl Lampland with the Lowell Observatory's 42-inch telescope. Lowell Observatory photo.

NGC 2281 is one of the most attractive clusters in Auriga. If you haven't seen it, wait no longer.

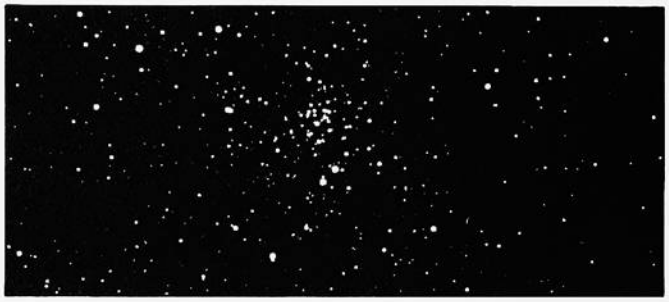
To the east, Gemini also holds many telescopic treasures. **Castor** (Alpha [α] Geminorum) is, to some, the finest double star north of the celestial equator. Castor A and Castor B are readily visible in amateur telescopes, shining at magnitudes 1.9 and 2.9, respectively. Both are actually double stars themselves, although not resolvable visually. With a period of 420 years, the position angle of the pair changes slowly from one decade to the next. In 1980, the p.a. was 95° and separation 2.2″. By 1990, a p.a. of 73° and separation of 3.0″ is predicted. A third star, Castor C (also known as YY Geminorum), is over 1000 astronomical units away from stars A and B. We see it (actually it's a pair of red dwarfs orbiting each other) as a 9th-magnitude speck at p.a. 164°, 72.5″ distant. All told in Castor's system of stars, there are six individual suns!

At the foot of the twin Castor, about 2.5° northwest of Eta (η) Geminorum, lies **M35** (NGC 2168), arguably one of the finest open clusters in the winter sky. Shining at magnitude 5.1, M35 is a marvelous sight in binoculars, and can even be seen with the unaided eye on clear winter nights. Many of the 150 stars seem to form curving rows and loops, "reminding one of the bursting of a sky rocket," as author Robert Burnham Jr. states. M35 measures a Moon's diameter across. At an estimated distance of 900 parsecs, the physical diameter of the cluster is 7.3 parsecs. Just southwest of M35 is the rich, distant open cluster **NGC 2158**. It glows dimly at magnitude 8.6, appearing as a nebulous cloud in 6 to 8-inch telescopes. Its stars are 12th magnitude and fainter, so only the largest backyard instruments resolve anything of the group. NGC 2158 is 4.9 kiloparsecs away — nearly six times as distant as M35 — on the outskirts of the Milky Way's disk. Be careful with this elusive fuzzy target: if you discover a "comet" near M35, it's probably NGC 2158 — an object that's existed for 800 million years!

A degree east of NGC 2158 is **IC 2157**, a small open cluster. Moderate-size telescopes display only 6 or 7 stars of magnitudes 10 to 12 set against a hazy background. The Webb Society's *Handbook*, Volume 3, mentions that IC 2156, another cluster, is just 7' north. They saw it as a half dozen stars, although I was unable to detect a clustering effect against the starry surroundings.

The twin Castor appears ready to punt **NGC 2129**, as this compact cluster lies at his toe. NGC 2129 consists of about 12 faint stars surrounding a triangle of 8th-magnitude suns. Medium powers provide the best views, since the group's apparent diameter is only 5′.

Take a look at the star 12 Geminorum. Do you see a faint glow around it? If so, congratulations! You have observed **IC 444**, an exceedingly faint reflection nebula. It is visible only in large telescopes, and then only with great difficulty; 7th-magnitude 12 Gem tends to overwhelm the faint nebular detail. Perhaps even more difficult is **IC 443**, a supernova remnant visible as a



Above: Known as the Eskimo Nebula, NGC 2392 is a small bright planetary located in Gemini. Photo by Martin C. Germano; 8-inch f/10 SCT, 103a-F emulsion, 3-minute exposure. *Right*: Located within the same low-power field as M38, the small star cluster NGC 1907 is visible in small telescopes as a clump of faint stars. Photo by Martin C. Germano; 8-inch f/10 SCT, 103a-F emulsion, 40-minute exposure.

curved arc of nebulosity measuring 25′ x 5′. Before trying to observe these difficult targets, make sure your optics are spotlessly clean — the slightest dirt will scatter the light and render both invisible.

Below the foot of Pollux is **NGC 2234**, another class 7 ("nonexistent") open cluster. Those using *Norton's Star Atlas* may already know about this little cluster, but both *Sky Atlas 2000* and the old *Skalnate Pleso* omit it. Although NGC 2234 is not terribly bright, it does contain a loose grouping of about 40 magnitude 11 and fainter stars. At least a 12-inch scope provides the best view of this group. Let us know what you see here; few observations exist of little-known objects like this one.

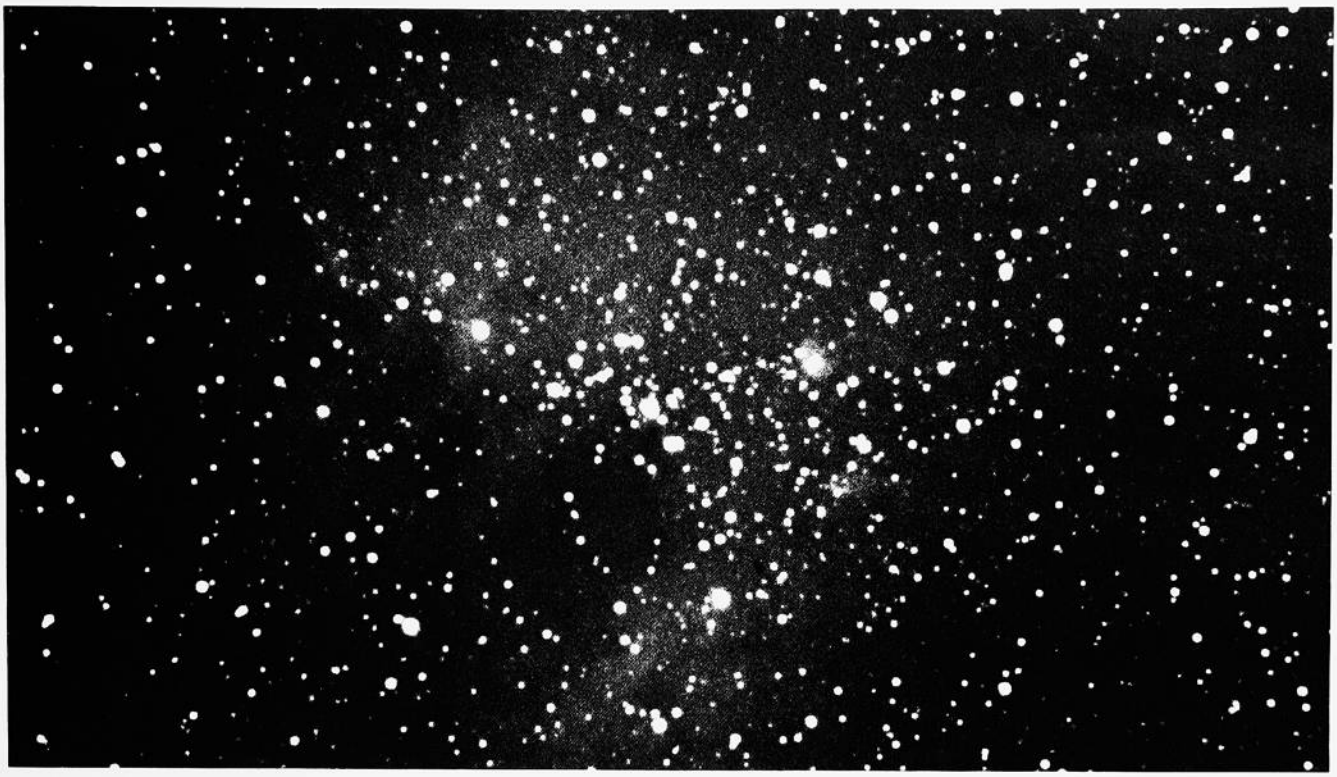
Far more appealing in smaller instruments is the open cluster **NGC 2304**, whose many faint stars bunch together in a 3′ diameter. A misty effect caused by countless dim stars is prominent at low power, yet quickly dissipates with higher power. **NGC 2266** is an even finer cluster; it consists of over three dozen stars, all packed within a 5′ diameter. As NGC 2266 shines with the light of a solitary 9th-magnitude star, even 20x binoculars begin to resolve the brighter members.

Few people can claim to have seen the sparse cluster **NGC 2331**. It is not plotted on popular star atlases, so few observers even know it exists. Yet by aiming my telescope toward the point specified in the Webb Society's *Handbook*, I was able to see 12 9th-magnitude stars spread out over a 16′ field. This one isn't rich as galactic clusters go, but it is distinguishable. Plot it on your star atlas, and give it a go on your next night out.

South of Gamma (γ) Gem is the faint open cluster **NGC 2355**. A little-observed group of 25 stars of 11th magnitude and fainter, NGC 2355 has an overall magnitude of 12. Try medium or high powers after you zero in on it. (Look for an 8th-magnitude star on the cluster's northern border.) Once aimed at NGC 2355, turn your clock drive off, if you have one, and allow the stars to drift across the field. In 10 minutes, you'll find **NGC 2395** centered in the field. This cluster is brighter than its neighbor to the west, holding some 50 stars in a 15′ diameter. Now try your luck with yet another nearby cluster, **NGC 2356**. This is one of the so-called class 7 groups, and so is unplotted and unlisted on most references. You'll need some luck to find it, as 2356 consists of only a few faint stars scattered within a triangle of 11th-magnitude suns.

Delta (δ) **Geminorum** is a fine binary star for amateur observers. The magnitude 3.5 primary is noticeably pale blue, while the magnitude 8.2 secondary is slightly yellowish in color. The pair is separated by 6.3″ at p.a. 223°. Trivia fans: What is historically significant about this star? Answer: In 1930, a young observer named Clyde Tombaugh found an out-of-place "star" near Delta Gem — the planet Pluto!

The prettiest planetary nebula of the season is **NGC 2392**, the "Eskimo Nebula." It shines at a photographic magnitude of 9.9 and measures 13″ across — it is small but bright enough to be spotted even in a 2-inch telescope. My 8-inch at 120x reveals a ghostly



Above: Immersed in a huge cloud of faint nebulosity is the star cluster NGC 1893 in Auriga. The surrounding nebulosity, known as IC 410, can be glimpsed on dark nights with a 6-inch or 8-inch telescope. Photo by Martin C. Germano; 8-inch f/10 SCT, 103a-F emulsion, 75-minute exposure. *Left*: NGC 1883 is a small bright open cluster in Auriga. Photo by Martin C. Germano; 8-inch f/10 SCT, 103a-F emulsion, 50-minute exposure.

bluish disk surrounding the 10th-magnitude central star. Photographs of this nebula show two distinct rings of nebulosity separated by a dark zone. The inner ring has a mottled appearance loosely resembling a face, while the dim outer ring encircles it like the fur-lined hood of a jacket, creating a celestial "eskimo." The nebula's age has been estimated to be 1700 years, making it one of the youngest planetaries known.

A more challenging planetary is **NGC 2371-2**, located below Castor and Pollux. I found it difficult in my 8-inch, and finally spotted it one very transparent night last year. It might be appropriate to nickname NGC 2371-2 the "Littlest Dumbbell", as its appearance is very similar to M76, the "Little Dumbbell" in Perseus. NGC 2371-2 measures 55" across and shines with a faint gray hue; I didn't observe its 15th-magnitude central star in the 8-inch scope. What is the smallest telescope that will reveal NGC 2371-2, and how about its central star?

Variable star observers are fascinated by the eruptive star **U Geminorum**. Discovered in 1835 by the English astronomer J.R. Hind, U Gem spends most of its time shining at an unimpressive 14th magnitude. Then, at irregular intervals, it becomes as much as 100 times more luminous, brightening to 9th magnitude. U Gem alternates between a long maximum lasting about 17 days and a short maximum of 9 days, then fades to normal brightness. Spectroscopic observations at Mount Wilson have led astronomers to conclude that U Gem is an unusual binary system. One star is a type G yellow dwarf, the other is a type sdBe blue dwarf. The period of revolution is a mere 4.5 hours with a separation of only a few hundred thousand miles. An extensive study in 1965 by astronomer W. Krzeminski revealed that both stars are eruptive, with the type G star responsible for 90% of the brightening.

Our winter tour ends with **NGC 2420**. Many observers pass this galactic cluster by. The Webb Society's *Handbook* makes brief mention of it. Yet telescopes reveal a rich congregation of 100 stars captured in a 10' field. They range in luminosity from magnitude 11 to 18, combining to an overall magnitude of 8.3. Don't be left out in the cold by ignoring NGC 2420 for another year.

* * *

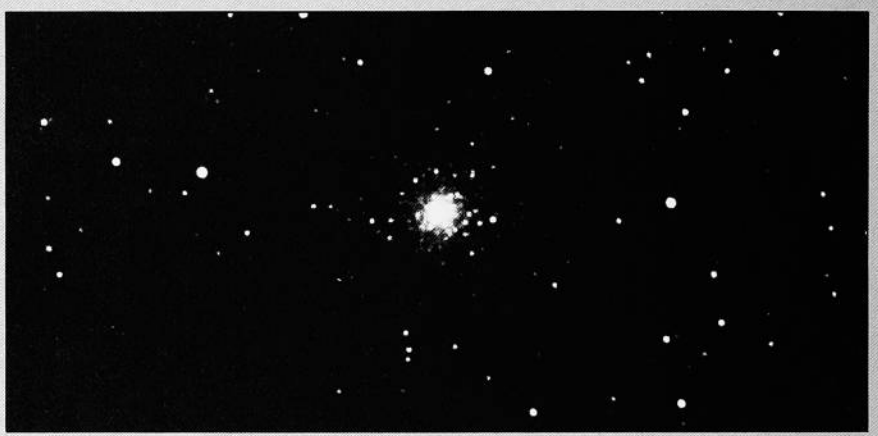
As grand old Comet Halley swings by the Sun and gets bright enough to see this winter, take a good few looks at it. But don't forget about the rest of the winter sky — particularly the rich Milky Way in Auriga and Gemini — and let *Deep Sky* know how you did in observing these objects. Although it can be mighty cold under the stars during winter, the many fabled clusters and nebulae along this section of sky — along with good hot coffee or chocolate — compensate for freezing your eyepieces off.

Phil Harrington is an experienced deep-sky observer and frequent contributor to Deep Sky; *his last article was "Secrets of the Summer Sky" in* Deep Sky 11.

Small Scope Showcase

Winter's Chilly Delights

by David H. Levy



Top: The Crab Nebula is a misty oval of light in small telescopes. Photo by Tom Eby. *Above*: M79 is the brightest globular visible during winter. Photo by Tom Dessert.

It was so cold the tube froze to the mount. I had to wait for daylight before I could rescue the telescope.

That happened one bitterly cold night. The session itself had gone well, and I didn't realize just how cold it was until it was time to go inside and the telescope would have none of it. Many of us undergo similar trials by ice in a sort of coming of age — like Ken Hewitt-White, whose eyebrow froze to the eyepiece one night in what turned out to be a very long observation of a single deep-sky object.

We're in winter now, the warm days of summer a distant memory, and if we want to observe the colors of M42 or the dust in the Pleiades, we're going to have to go cold turkey. That means heavy coats, earmuffs, and everything else we can think of to keep warm.

I once developed a unique way to keep my ears warm. Instead of earmuffs I put on a thick set of headphones that were connected by a long wire to a tape recorder playing music from the warmth of my bedroom. And to help the things go I would hum or mumble along with whatever music was playing. I must have looked really strange, standing outside in 15 below, connected to a long wire and humming.

But it was worth it for I was looking at **M42**, the magnificent nebula in Orion — the heavens' most spectacular deep-sky object in almost everybody's opinion. In fact there isn't just one Orion Nebula, but many. There's a different Orion Nebula for every telescope you look through. The binocular Orion, under a dark country sky, looks like a bright fuzzy patch and, if you have terrific eyes, it might even show a tiny shape.

The small-refractor-in-the-city Orion Nebula is definitely worth a close look, as you will see the famous Trapezium, four close stars in the center that brighten anybody's winter night.

The 5-inch or 8-inch Schmidt-Cass Orion Nebula starts to reveal color, and if the telescope is out in the country, you'll see a conflagration of gas and stars that will take your breath away. The 8-inch version has nebulosity extending well past what smaller scopes will see, and this might encourage you to switch to a system that provides a wider field of view.

Schmidt-Cassegrains are designed with long focal lengths, which yield high magnifications and narrow fields of view. If you use a telescope with a shorter ("faster") focus, the magnification is lower and the field wider. The results are dramatic: with a 5-inch or 6-inch f/4 scope and a low power eyepiece, the Orion Nebula ocupies the center of a field studded with bluish stars. Even now, after observing it for over 20 years, I still get a chill down my backbone whenever I look at this nebula with such a telescope.

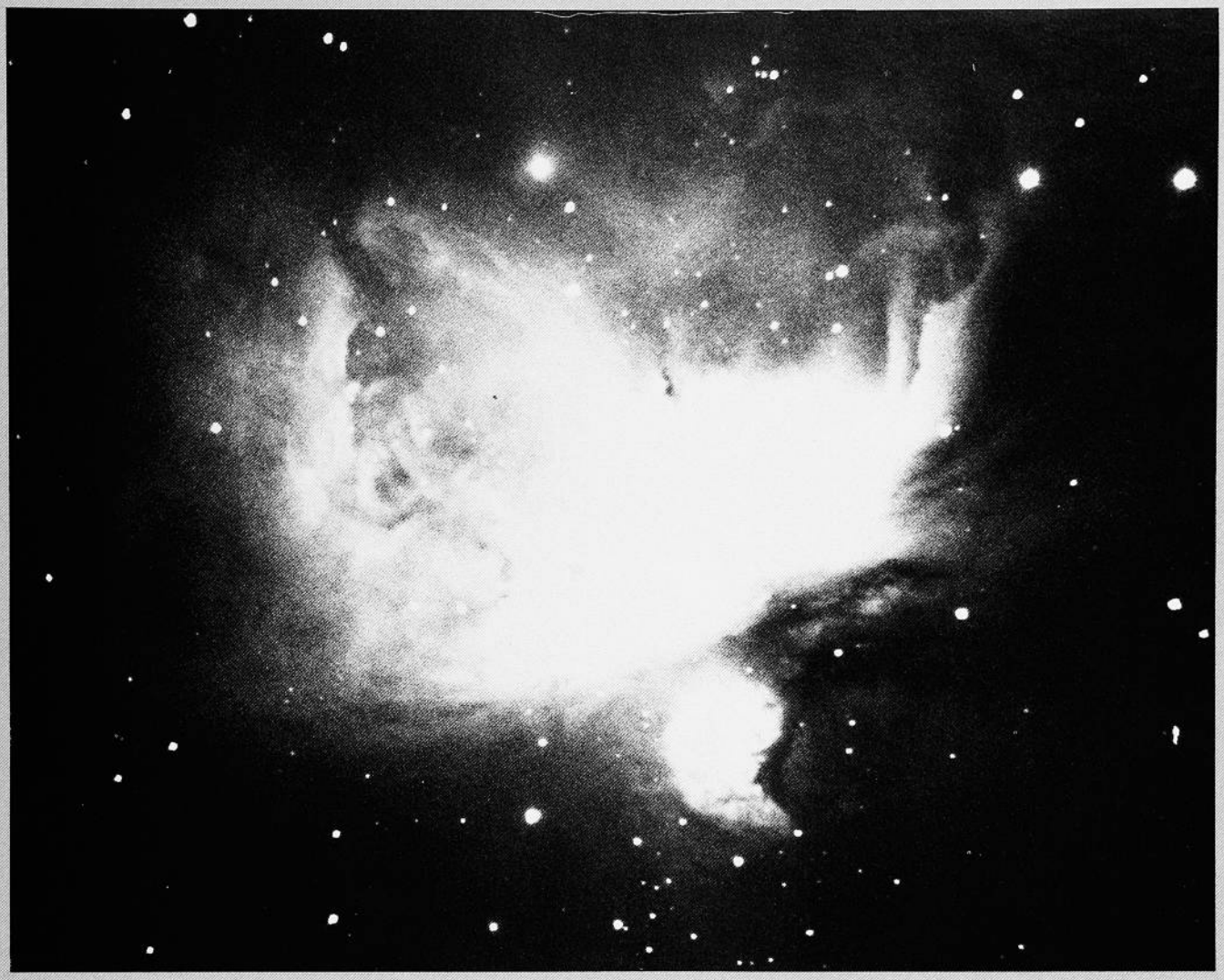
The advantage of a small, short-focus telescope is that its large field increases the contrast between the nebula and surrounding stars. In fact, you may prefer the striking low-power view to the detailed look at the central part of the nebula that the longer-focus SCTs provide. A wide field lets you pick out places where the nebula runs thick or thin. You can actually see the structure of this immense nebulous celestial "flower."

Yet what about the *real* Orion Nebula? Although we can say that there is a different nebula in each scope, they all lie in the same spot in our Galaxy, a mere 1600 light-years away. At the speed of light, you could cross it in about 25 years.

The Orion Nebula is part of a monstrous stellar nursery that fills much of Orion. All that glowing gas is hydrogen, basic star-stuff, and the hot blue stars you see here have only recently — some within the past few million years — ignited to join the galactic family. Some of these stars, seeking a cosmic equilibrium, vary in brightness, "flickering" by a fifth of a magnitude or so in as little as ten minutes. There are so many such stars, and the brightness change is so slight, that observing them is extremely difficult even for the most experienced observers.

All these are young stars just turning on — our Sun many have begun in similar fashion, and the stars of its "Orion Nebula" now spread throughout the Galaxy. When we look at the Orion Nebula, we aren't just seeing an object in the sky; instead we're observing the exquisite process of star formation taking place before our eyes.

The Orion Nebula has but one problem — its place in the winter sky.



A favorite deep-sky object for many observers, the Orion Nebula (M42) is a fuzzy "star" to the naked eye and a large nebulous glow to small telescopes. How many stars can you see inside the nebulosity? Photo by Rick Dilsizian.

It's always cold when we have to observe it! Rumor has it that one observer, who reported temperatures so cold that the light from the nebula froze between the eyepiece and his eye, had to bring it inside in a box so it could thaw out and become visible.

If the Orion Nebula shows what happens when stars are born, the **Crab Nebula** in Taurus shows what remains when a star dies. Located about a degree northwest of 3rd-magnitude Zeta (ζ) Tauri, the Crab looks best under a moonless country sky. Through a 6-inch or larger telescope this small oval patch of haze then actually does look something like its namesake.

It's also one of the newest deep-sky objects: Chinese astronomers recorded a brilliant "guest star" at its location in the early summer of 1054. About 15 years ago, astronomers at the University of Arizona discovered the remains of the star that caused it all. It was a pulsar — the tiny, whirling, superdense fragment of a star left over from the supernova that terrified a whole culture a millennium ago.

Of course, the frigid winter sky has other fine sights. In Auriga you'll find several open clusters that look their best in fast, short-focus, rich-field telescopes. **M36, M37, M38** are three of the finest such clusters in the constellation. Yet Auriga lacks what I think is the most spectacular winter cluster. No, I'm not thinking of the Pleiades, but rather **M35** in Gemini. This magnificent cluster, which sprinkles your field of view with bright little points of light, is one of winter's great showpieces. If you have an 8-inch telescope, you may even glimpse its companion open cluster half a degree away to the southwest. This is 12th-magnitude **NGC 2158**, which provides an interesting contrast to its much more prominent neighbor. The two aren't connected physically: M35 lies about 2200 light-years away and NGC 2158 is 16,000 light-years off. In fact, the small cluster is hard to resolve in any telescope smaller than 8 inches, and has been mistaken for a comet by novice observers.

Open clusters form only half the star cluster genus, with globulars filling out the scheme. Globulars are rare in the winter sky, however, yet you'll find one in Lepus, just south of Orion. **M79** looks like a featureless blob in small telescopes, but with good seeing and an 8-inch telescope under rural skies, you should be able to resolve its myriad stars.

Let's end with a couple of more challenging winter objects, the **Christmas Tree Cluster** and **Hubble's Variable Nebula**. The Christmas Tree is a striking asterism known more formally as NGC 2264; it looks, well, something like a Christmas tree. NGC 2264 comprises some 20 bright stars and many fainter ones. The cluster extends almost half a degree, so it will stand out best in low-power fields of view.

Hubble's Variable Nebula (NGC 2261) surrounds the variable star R Monocerotis. Apparently both the star and nebula are variable, the nebula both in brightness and size. Careful observers with large telescopes and moderately high magnifications may notice changes in the details of its structure, over nights or weeks.

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Photographing Winter's Star Clusters

by Robert Burnham

Circling the sky like a giant band of silver, the Milky Way displays its richest fields twice a year. In summer, the glorious run of stars from Cygnus south to where Centaurus pokes above the horizon makes an unforgettable sight. And though somewhat less brilliant, the winter sky's companion-piece in Auriga through Canis Major and Carina also abounds with starry vistas to photograph.

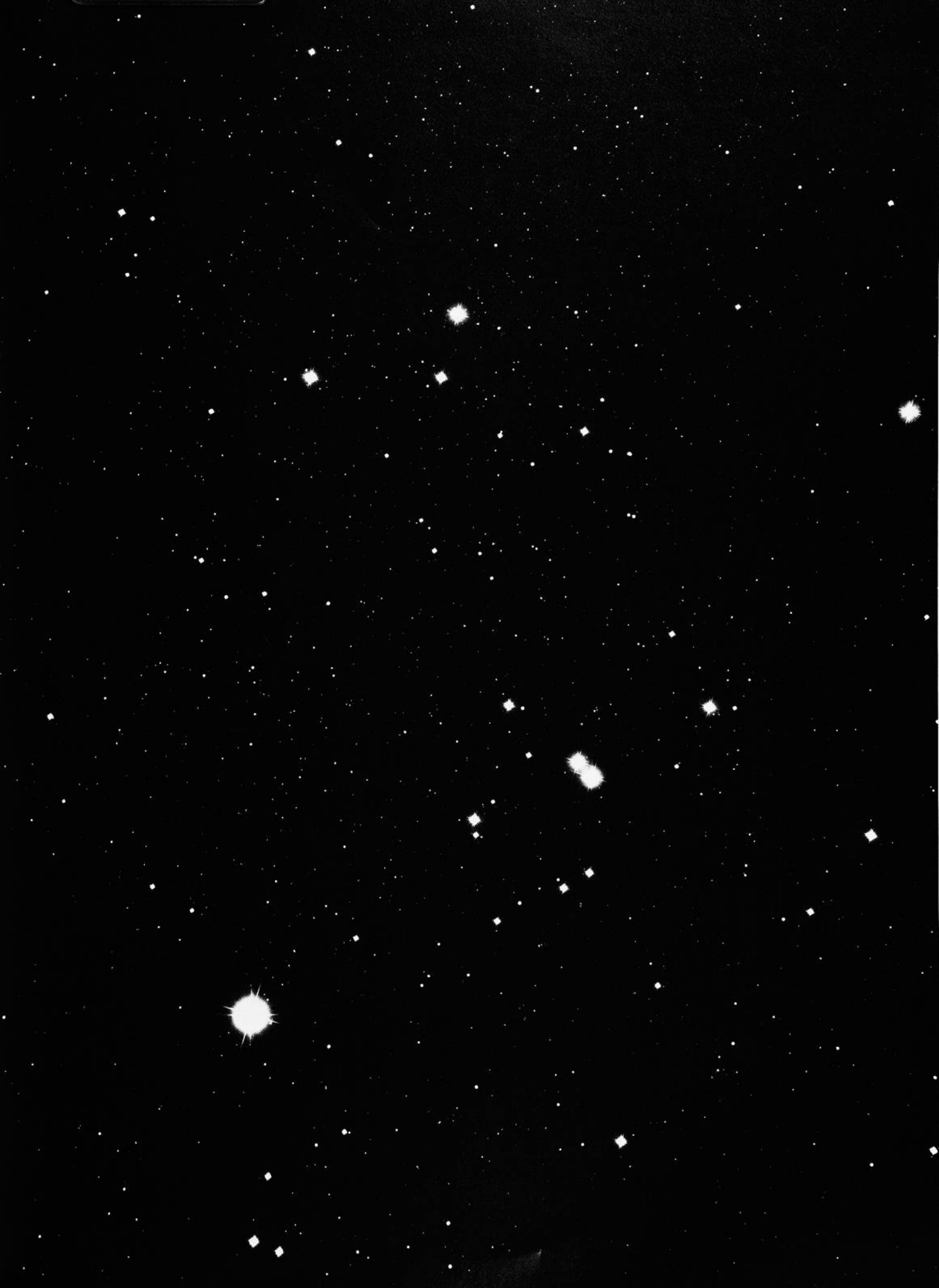
The most abundant deep-sky objects along the winter Milky Way are star clusters. These range in size from large sparse groups like the Hyades down to tiny stellar knots like NGC 1907. Since their apparent size varies significantly, so does the equipment you'll need to photograph them: loosely congregated clusters are best approached with a telephoto lens riding piggyback on your telescope, while small tight clusters require the image scale of a large telescope at prime focus.

The Basic Gear

Fundamental to both approaches is an equatorially-mounted telescope. Its size and focal ratio actually matter less than having a sturdy and reliable mounting — one that points where you want it to, stays put when aimed, and allows precise control over its tracking for guiding.

Unfortunately, most commercial equatorial mountings go longer on looks than steadiness. Often a large part of preparing for astrophotography consists of devising ways to work around the drawbacks of your mounting. For example, your German equatorial may have a hollow pier with three legs bolted on at the base. These can be improved by attaching angle-iron braces that run from the top of the pier out to the ends of the legs, creating triangles for stability. You might also fill the hollow pier with sand or concrete. With the typical splay-footed tripod, you'll need adjustable tie-braces to keep the legs firmly in place. Connect the braces about halfway between the ground and the equatorial head. From the head itself, hang a 5 to 10 pound weight low

Left: **Filmy veils of dust enshroud the Pleiades. Photo by Martin Germano using an 8-inch f/5 Newtonian and a 35-minute exposure on 103a-F.** ***Right:*** **the core of the Hyades. Photo by Paul Roques with a 4-inch Schmidt camera on hypered 2415.**



to the ground; this extra mass helps the tripod damp out wiggles and shakes.

Since no telescope drive runs perfectly, you'll have to monitor how well yours performs and make corrections with an electric drive corrector. To check the drive, place a brightish star on a crosshair in an illuminated reticle eyepiece; then keep the star aligned by speeding up or slowing down the drive rate. Adjustments in declination are done with the manual slow-motion control on the declination axis.

The next piece of equipment you'll need is either a separate guidescope that rides on the main telescope or an off-axis guider that picks up light from a guide star in the field of view of the main telescope's optics. Separate guidescopes offer more versatility, since you won't always find a bright enough guide star in the same field of view as what you're photographing. A common arrangement combines a 2.4-inch refractor riding on an 8-, 10-, or 12-inch Newtonian. Just make sure that the guidescope's focal length yields magnifications high enough for you to see and correct tracking errors before the film "sees" them.

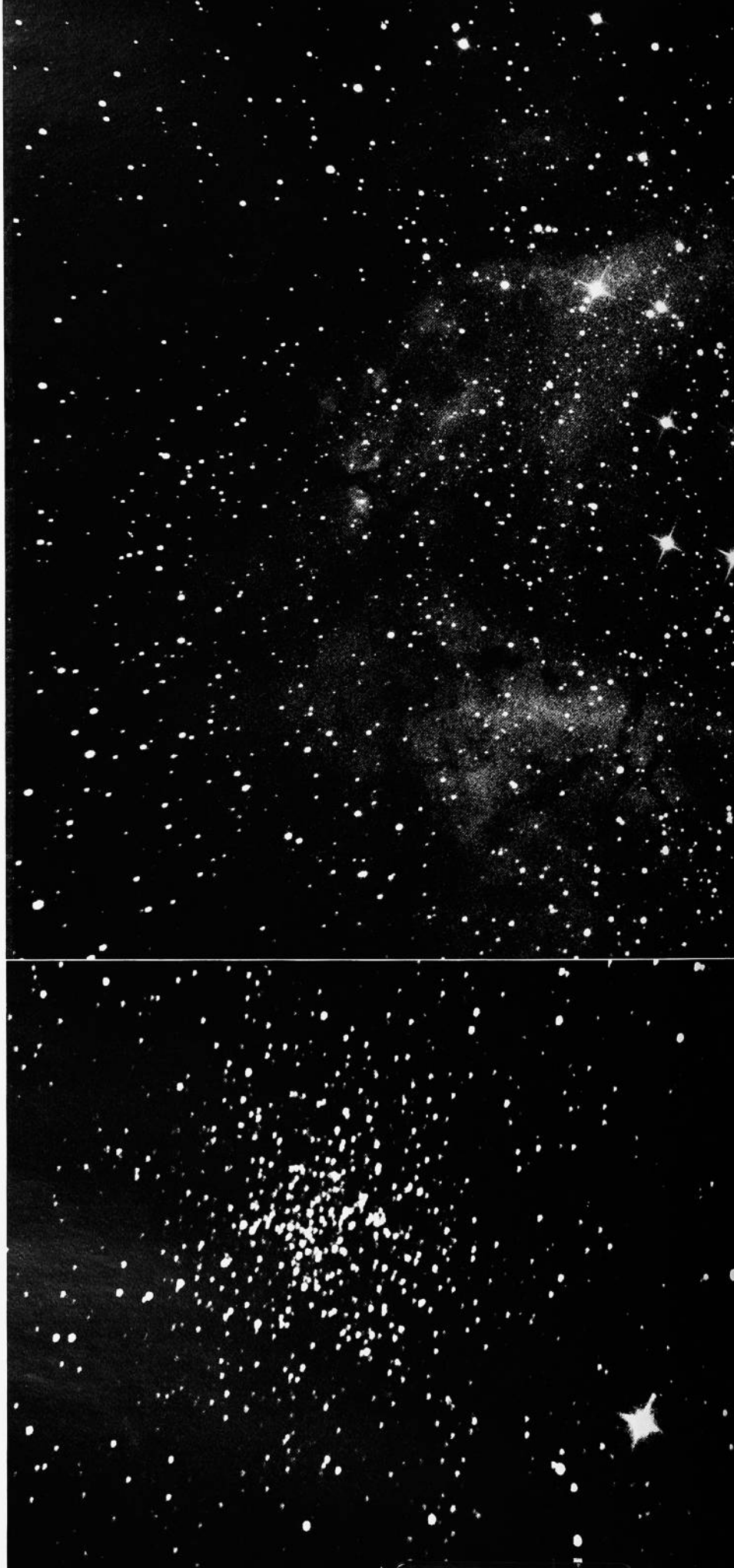
For all their versatility, separate guidescopes have a reputation for "flexure." Flexure occurs when the guidescope's optical axis doesn't remain firmly fixed relative to the main telescope's axis. The result of this slippage is trailed star images. Accordingly, off-axis guiders — where both the guiding image and the taking image come from the same optics — have become popular.

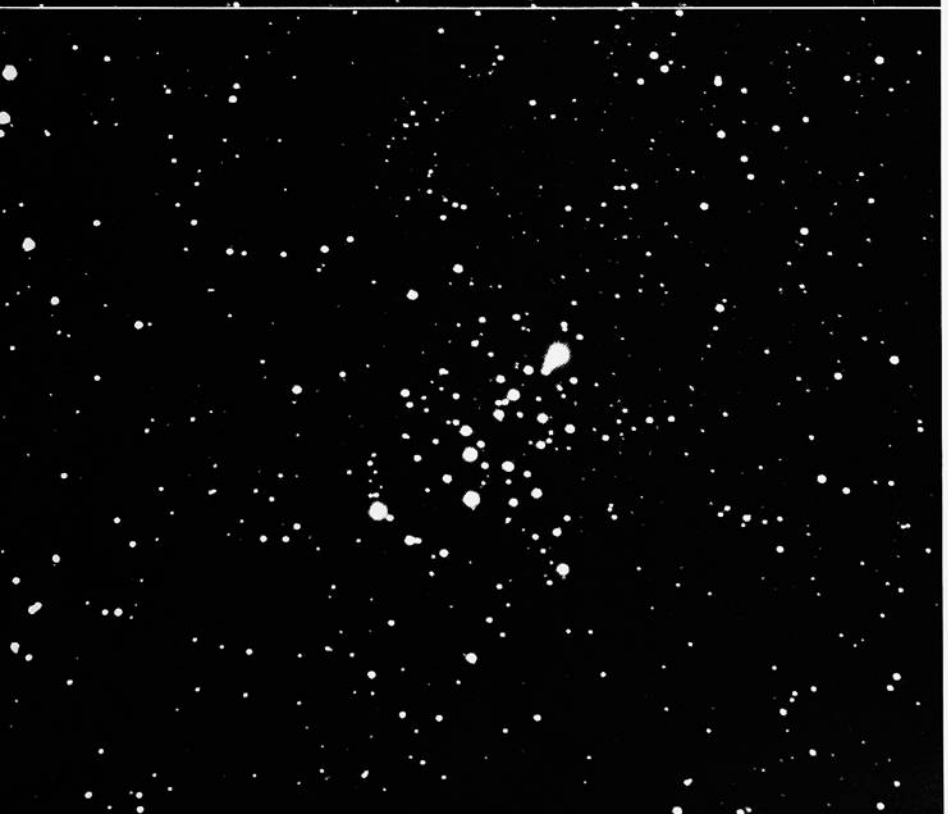
Which to choose? Both have ardent defenders, but most people find a separate guidescope easier to use — and when secured properly, flexure is negligibly small.

Your last big piece of equipment is a camera; if you have an SLR with an adapter to couple it to the scope's focuser, you're all set. Many experienced astrophotographers replace the standard Fresnel ring and microprism focusing screen with either a plain ground-glass screen or a clear one, since these make focusing easier at slow f/ratios. However, if your camera can't be altered or if you don't want to spend the money, you can make do with the standard screen which probably has a gound-glass area surrounding the central microprism region. Focusing is just slightly more awkward.

Films, Films, Films

When choosing film, there are many possible choices. For black and white, Kodak's Technical Pan 2415 is a clear winner in the opinion of everyone who uses it. As manufactured, the film has a 1951-era speed rating (ISO 50), but it hypersensitizes very well (via baking, forming gas, or both) and withstands an astonishing degree of enlargement before grain becomes objectionable. It's





pretty well superseded the old 103a series spectroscopic films.

For color negatives, Fuji's HR 1600 holds sway in the speed ratings, though a new Sakura film of the same speed (marketed sporadically, often under the Konica brand name) is rated tops among Japanese astrophotographers. Kodak's VR 1000 and VR 400 films are also very popular, and are usually easier to obtain than Fuji's. (Agfa's 1000-speed color negative film seems to have made little impact on astrophotographers so far.)

For color transparencies, most astrophotographers choose one of the 400-speed films, typically Ektachrome or Fujichrome. Ektachrome has a good blue response, so it does very nicely on reflection nebulae and the arms of spiral galaxies; Fuji tends to have a better red response and therefore works well on HII regions and globular clusters. Though not widely used yet, many good astrophotos have been taken on Ektachrome P800/1600 — but it's hard to find except in large city photo stores. In the past year, 3M 1000 slide film has also been making noticeable inroads, but so far there's little "accumulated wisdom" on it. Like Tech Pan, both color slide film and negative film reach their best sensitivity when hypered.

Getting Set Up

Since you're photographing points of light, you can take surprisingly good photos of star clusters under rather light-polluted skies. Yet while the brightest stars always record well, the luminous sky between them places a limit on how long you can expose and consequently how faint your photo can go. Two to five minutes seems to be about the limit for most urban areas, though you can stretch this to perhaps 15 minutes if you're working at f/ratios longer than 10. But if you're going to all the trouble of taking a guided astrophoto, why waste time in town? Head for dark skies!

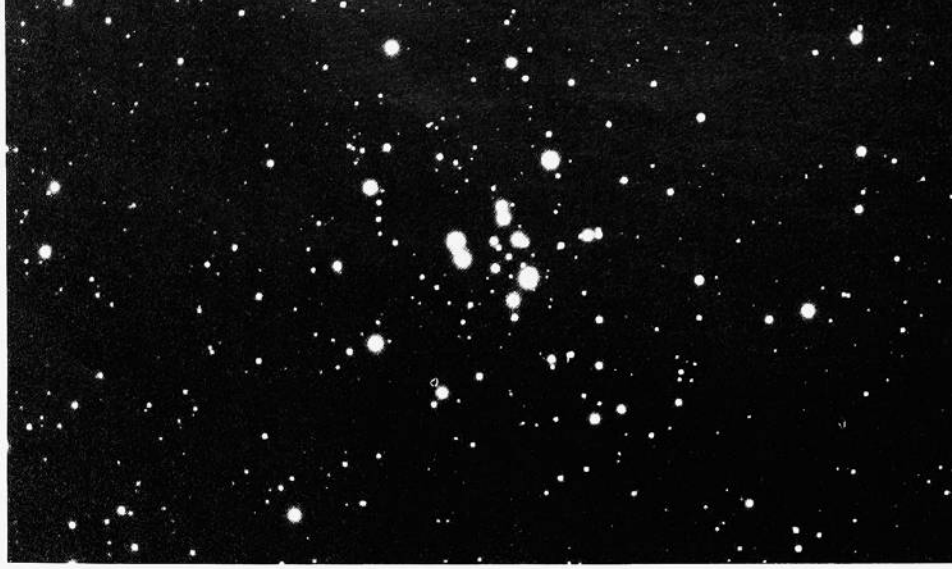
A few lucky astrophotographers have access to rural property with such amenities as bathrooms, electric power, and a place to warm up. Most of us have to make do with our own resources, however. Fifty miles from home is no place to find out that you left an essential Allen wrench back in the workshop. Therefore, one of the best investments you'll ever make in your astrophotographic and observing career

Left above: **NGC 2244 is the star cluster in Monoceros that is surrounded by the Rosette Nebula. Photo by Preston Justis using a 10-inch f/6 scope and a 90-minute exposure on 103a-F.** ***Far left:*** **NGC 2477 is a rich cluster in Puppis — Dale Lightfoot's photo was taken with an 8-inch f/5 Newtonian and a 22-minute exposure on 103a-F.** ***Left:*** **M103 is a loose cluster in Cassiopeia. Photo by Martin Germano, who used an 8-inch f/10 SCT and a 30-minute exposure on 103a-F.**

Winter's Open Clusters

Object	M#	R.A. (2000) Dec.	Con.	Mag.	Mag.*	N*	Diameter	Distance kpc
Blanco 1	—	0h04.3m −29°56′	Scl	4.5	5.02	30	90′	0.3
NGC 129	—	0h29.9m +60°14′	Cas	6.5	8.57	35	21′	1.6
NGC 225	—	0h43.4m +61°47′	Cas	7.0	9.26	15	12′	0.6
NGC 188	—	0h44.4m +85°20′	Cep	8.1	12.09	120	14′	1.6
Dolidze 13	—	0h50.0m +64°08′	Cas	—	—	30	12′	—
NGC 457	—	1h19.1m +58°20′	Cas	6.4	8.59	80	13′	2.8
NGC 581	—	1h33.2m +60°42′	Cas	7.4	10.55	25	6′	2.6
NGC 659	—	1h44.2m +60°42′	Cas	7.9	10.43	40	5′	2.1
NGC 663	—	1h46.0m +61°15′	Cas	7.1	8.42	80	16′	2.2
Collinder 463	—	1h48.4m +71°57′	Cas	5.7	8.49	40	36′	0.6
NGC 752	—	1h57.8m +37°41′	And	5.7	8.96	60	50′	0.4
Stock 2	—	2h15.0m +59°16′	Cas	4.4	8.18	50	60′	0.3
NGC 869	—	2h19.0m +57°09′	Per	4.3p	6.55	200	30′	2.2
NGC 884	—	2h22.4m +57°07′	Per	4.4p	8.05	150	30′	2.3
IC 1805	—	2h32.7m +61°27′	Cas	6.5	7.87	40	22′	2.1
NGC 957	—	2h33.6m +57°32′	Per	7.6	9.49	30	11′	2.2
Trumpler 2	—	2h37.3m +55°59′	Per	5.9	7.38	20	20′	0.6
NGC 1039	M34	2h42.0m +42°47′	Per	5.2	7.33	60	35′	0.4
IC 1848	—	2h51.2m +60°26′	Cas	6.5	7.10	10	12′	2.2
NGC 1220	—	3h11.7m +53°20′	Per	11.8p	13p	15′	1.6′	—
Trumpler 3	—	3h11.8m +63°15′	Cas	7.0p	—	30	23′	—
NGC 1245	—	3h14.7m +47°15′	Per	8.4	11.16	200	10′	2.3
Stock 23	—	3h16.3m +60°02′	Cam	—	—	25	15′	—
Melotte 20	—	3h22.0m +49°00′	Per	1.2	2.88	50	185′	0.2
Pleiades	—	3h47.0m +24°07′	Tau	1.2	2.87	100	110′	0.1
Tombaugh 5	—	3h47.8m +59°03′	Cam	8.4	11.62	60	17′	1.8
NGC 1528	—	4h15.4m +51°14′	Per	6.4	8.75	40	24′	0.8
Hyades	—	4h27.0m +16°00′	Tau	0.5	3.40	—	330′	0.05
NGC 1582	—	4h32.0m +43°51′	Per	7.0p	9p	20	37′	—
NGC 1647	—	4h46.0m +19°04′	Tau	6.4	8.61	200	45′	0.6
NGC 1664	—	4h51.1m +43°42′	Aur	7.6	10.56	—	18′	1.2
NGC 1746	—	5h03.6m +23°49′	Tau	6.1p	8p	20	42′	0.04
NGC 1807	—	5h10.7m +16°32′	Tau	7.0	8.60	20	17′	—
NGC 1817	—	5h12.1m +16°42′	Tau	7.7	11.17	60	16′	1.8
Czernik 20	—	5h20.1m +39°28′	Aur	—	—	12	18′	—
Berkeley 17	—	5h20.6m +30°36′	Aur	—	16p	100	14′	—
Berkeley 18	—	5h22.2m +45°24′	Aur	—	16p	300	20′	—
NGC 1893	—	5h22.7m +33°24′	Aur	7.5	9.31	60	11′	4.0
NGC 1883	—	5h25.9m +46°33′	Aur	12.0p	14p	30	2.5′	—
Collinder 65	—	5h26.0m +16°00′	Ori	3.0p	—	—	220′	—
NGC 1907	—	5h28.0m +35°19′	Aur	8.2	11.26	30	7′	1.4
NGC 1912	M38	5h28.7m +35°50′	Aur	6.4	9.53	100	21′	1.3
Trapezium	—	5h35.4m −05°23′	Ori	3.7	—	—	48′	0.5
NGC 1960	M36	5h36.1m +34°08′	Aur	6.0	8.86	60	12′	1.3
Collinder 70	—	5h36.0m −01°00′	Ori	0.4	1.69	100	150′	0.4
NGC 2099	M37	5h52.4m +32°33′	Aur	5.6	9.21	150	24′	1.4
NGC 2112	—	5h53.9m +00°24′	Ori	9.1p	10p	50	11	—
NGC 2141	—	6h03.1m +10°26′	Ori	9.4	13.33	100	10′	4.4
NGC 2168	M35	6h08.9m +24°20′	Gem	5.1	8.18	200	28′	0.9
NGC 2175	—	6h09.8m +20°19′	Ori	6.8	7.55	60	18′	2.0
NGC 2244	—	6h32.4m +04°52′	Mon	4.8	5.84	100	24′	1.7
Trumpler 5	—	6h36.7m +09°26′	Mon	10.9p	17p	150	8′	2.4
NGC 2264	—	6h41.1m +09°53′	Mon	3.9	5p	40	20′	0.8
Collinder 121	—	6h54.2m −24°38′	CMa	2.6	3.79	20	50′	0.7
NGC 2323	M50	7h03.2m −08°20′	Mon	5.9	7.85	80	16′	0.9
NGC 2345	—	7h08.3m −13°10′	CMa	7.7	9.87	70	12′	1.8
NGC 2354	—	7h14.3m −25°44′	CMa	6.5	9.13	100	20′	1.9
NGC 2360	—	7h17.8m −15°37′	CMa	7.2	10.36	80	13′	1.6
NGC 2362	—	7h18.8m −24°57′	CMa	4.1	4.39	60	8′	1.6
Ruprecht 16	—	7h23.2m −19°27′	CMa	—	13p	15	11′	—
Collinder 140	—	7h23.9m −32°12′	CMa	3.5	5.36	30	42′	0.3
NGC 2374	—	7h24.0m −13°16′	CMa	8.0	10.74	25	19′	1.3
Melotte 66	—	7h26.3m −47°44′	Pup	7.8	11.41	200	10′	2.5
Dolidze 26	—	7h30.1m +11°54′	CMi	—	—	—	24′	—
NGC 2422	M47	7h36.6m −14°30′	Pup	4.4	5.68	30	30′	0.5
NGC 2423	—	7h37.1m −13°52′	Pup	6.7	9.02	40	19′	0.9
NGC 2420	—	7h38.5m +21°34′	Gem	8.3	11.06	100	10′	2.5
NGC 2437	M46	7h41.8m −14°49′	Pup	6.1	8.68	100	27′	1.7
NGC 2447	M93	7h44.6m −23°52′	Pup	6.2:	8.20	80	22′	1.1
NGC 2451	—	7h45.4m −37°58′	Pup	2.8	3.60	40	45′	0.3
NGC 2477	—	7h52.3m −38°33′	Pup	5.8	9.81	160	27′	1.3
NGC 2467	—	7h52.6m −26°23′	Pup	7.1p	—	50	16′	3.4:
NGC 2516	—	7h58.3m −60°52′	Car	3.8	7p	80	30′	0.4

Column 1: Designation in *Revised New General Catalogue* by J. Sulentic and W. Tifft (1973), *Index Catalogue* by J.L.E. Dreyer (1908), and additional lists. **Column 2**: Designation in *Connaissance des Temps* by Charles Messier (1784), and supplements. **Column 3**: coordinates for epoch 2000.0. **Column 4**: constellation in which object lies. **Column 5**: V magnitude; p denotes photograhic magnitude. **Column 6**: V magnitude of brightest cluster member; p denotes photographic magnitude.**Column 7**: number of stars in cluster. **Column 8**: diameter in arcminutes. **Column 9**: distance in kiloparsecs. Data from B. Skiff, Lowell Observatory, 1983-1985. Compiled by D. Kendzie-Holdaway.



M34 is a brighter open cluster in Perseus. Photo taken by T.L. Dessert with a 4-inch f/10 scope and a 15-minute exposure on 103a-F.

is a commodious box like those used for fishing tackle or mechanic's tools.

Make a check list and gather all the equipment you're likely to need for middle-of-the-night observing. Look beyond the obvious things like batteries for the red-lensed flashlight, eyepieces, extra film, and a second cable release. How about a first-aid kit? Or insect repellent? A roll of duct tape? A hair dryer? Additional heavy-duty extension cords? A stool to sit on? And baggies to keep those little miscellaneous things in? Try to think of everything that could force a halt to your expedition if it broke, wore out, or got lost, and pack along a replacement. For tools, get inexpensive extra sets of pliers, wrenches, and screwdrivers; dedicate a hammer to your hobby. Keep the "observing" tools with your astrophoto gear, and separate from your regular tools.

Finally, lay all the stuff out on the kitchen table and take a good look at it. (Appalling, isn't it, how much you need?) Now go out to K Mart or Sears and shop for the toolbox or tackle box to carry it all.

At most remote sites, you can get your electricity from the car battery by means of an inverter plugged into the cigarette lighter. (These are commonly available from telescope accessory shops along with drive correctors.) Just make sure your car battery is in good shape (not a bad idea, anyway). On occasion, you'll have to observe along a roadside that carries some traffic. Experienced observers build a two or three-sided freestanding lightweight folding shelter out of wood and cloth or wood and cheap paneling. They erect these to screen the telescope from vehicles' headlights. These shelters can't withstand much wind, but do okay in a light breeze and can reduce bone-chilling cold to merely uncomfortable.

Polar aligning the telescope is a technique that varies depending on the mounting design. Follow the manufacturer's instructions or see David Healy's article in DEEP SKY #4.

When you've found your target cluster, switch the drive on, focus the telescope, and locate a suitable guide star (not too bright, not too dim). Then cover the taking lens of the camera with a sheet of stiff black cardboard. (The inside of a Kodak or Agfa photo-paper envelope or box is ideal.) Trip open the shutter with a cable release, wait until the guide star stops dancing on the eyepiece crosshairs, and gently remove the cardboard to start the exposure.

The next 10 minutes, 20 minutes, or whatever are an exercise in boredom control. Your nose will itch and ditto for your hind end. You squirm on your seat, being careful not to jiggle the scope, and gently twiddle the drive corrector controls whenever the star begins to drift. Now's the time to review all those dumb decisions you've made in the course of your life. Are you in the right career? Does your boss think you're weird for doing things like this? And what about the spouse and family? Will they ever understand why you *need* that $120 eyepiece?

Pretty soon you notice the drive runs fine for about a minute, then needs a little touching up. Knowing this, you can snatch glimpses of the night sky and take the crick out of your neck as you lean back to look up. All around the sky are stars, right down to the hilltops. The winter Milky Way isn't bright, but it's unmistakably there — sweeping from Auriga high overhead down past Orion, through Monoceros to Canis Major and below.

What a beautiful night! It's for nights (and places) like this that you got into astronomy in the first place — why can't more people appreciate it?

"Ding."

The timer, real or mental, declares the end of the exposure. Carefully you recover the aperture with the cardboard and close the shutter. You get up, stretch stiffly, jog in place for a moment, and then it's back to business: slowly you wind the film onto the next frame. Easy does it now! Cold film is brittle and in the low humidity, static electricity can zap it with little lightning marks, ruining the photo you just half-wrecked your spine to get.

You look up the next cluster on your list, find and center it in the camera viewfinder, reset the focus, and locate a nearby guide star. You enter the particulars in the log, run the red flashlight beam over the equipment to check that everything's in place, scratch your nose, and hunker down again.

Where was I? Oh, yeah, the eyepiece. Maybe if I argued that . . . .

Sparkly Little Jewels

Open, or galactic, star clusters are groups of stars that contain anywhere from a few to several hundred members. Most open clusters are "bare" — they contain stars and that's all. But the Pleiades and several other clusters offer an interesting difference: their stars are surrounded by remnants of the dust and gas that the stars were born from. In effect, by photographing a cluster you get a nebula thrown in free. (Try photgraphing NGC 2244, the cluster in the middle of the Rosette Nebula, to see this.)

Since they were born together, the stars in a cluster tend to stick close for most of their lives. Moreover, since they are born out of the dusty gas of the Galaxy's spiral arms, these clusters throng the galactic plane. Even those that appear far from the Milky Way (such as the Pleiades) still inhabit the plane; they merely lie so close to us that perspective has shifted their position.

Yet a cluster isn't forever: over the eons, the gravitational pull of other matter in the Galaxy will slowly disrupt the cluster, destroying its integrity. But this takes a long, long time to happen; meanwhile, we see a splendid array of tiny sparkling stellar jewel boxes that lines the Milky Way.

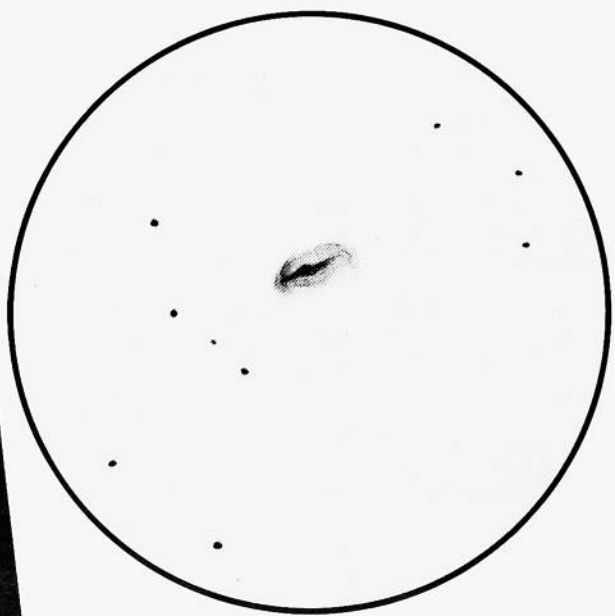
There's far more here than you can photograph in a season. Take the list on the opposite page and pick out 10 clusters. They should range from big bright ones (M 45 and M 35) down to tiny ones like NGC 1907 and NGC 2362. This gives you a realistic goal for your first efforts. When you've finally secured photos of these objects that you're pleased with, pick another 10 or 15 clusters from the list and go on.

Whatever you do, don't rush! This is supposed to be fun, remember. You're not in competition with anyone. It's like taking a 100-mile bike trip. If you don't learn to take your mind off each one of those 100 miles you have to cover, you'll never have enough mental energy to get over that first big hill.

Deep Sky Sketchbook

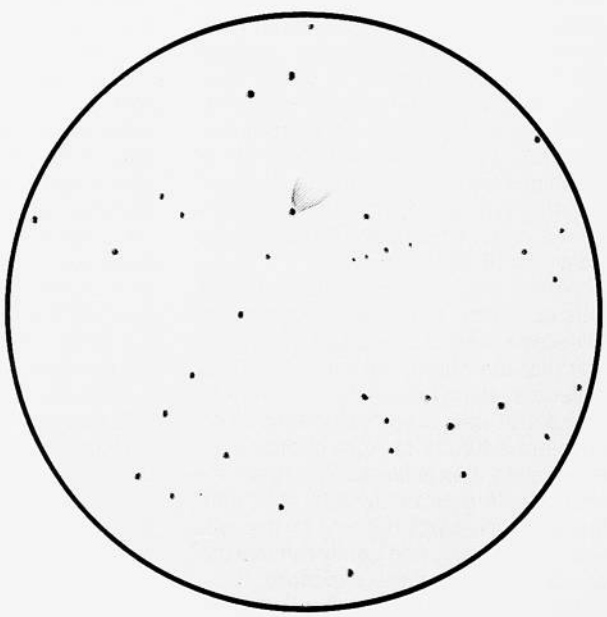
This issue's sketchbook contains drawings from Cheryl C. Chellel, of Glen Mills, Pennsylvania, who has been observing with her 8-inch f/10 SCT. Cheryl is a member of the Delaware Valley Amateur Astronomers and has sketched over 100 deep-sky objects.

Yours Truly, D. Eicher



← NGC 2903 90x

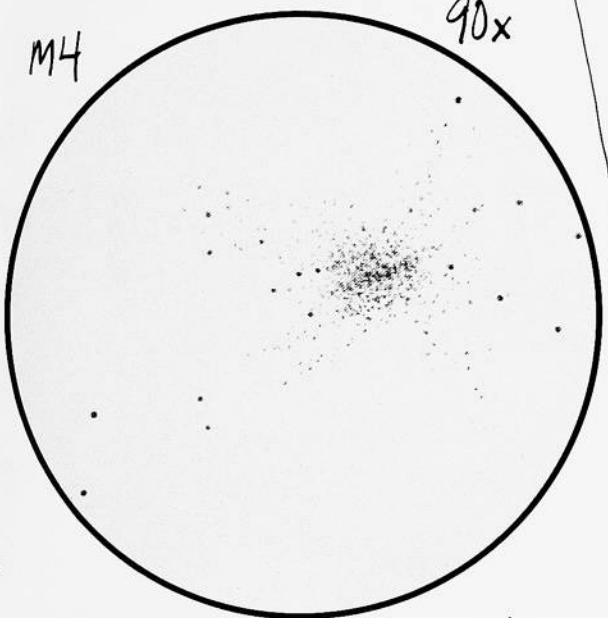
galaxy in Leo with subtle spiral structure.



NGC 2261 90x →

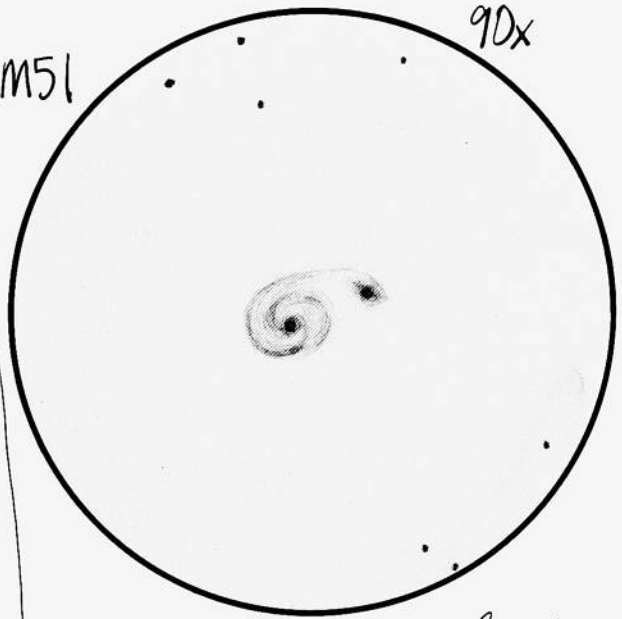
Hubble's Variable Nebula: a nebulous triangle of weak light.

M4 90x



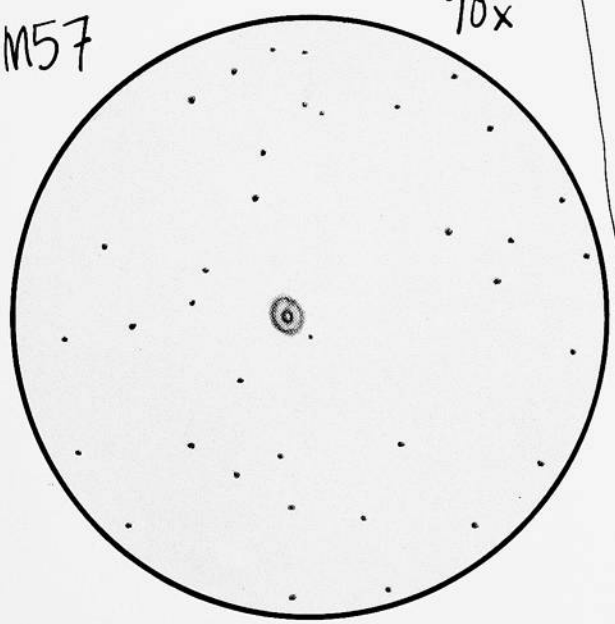
globular in Scorpius; note lanes of stars

M51 90x



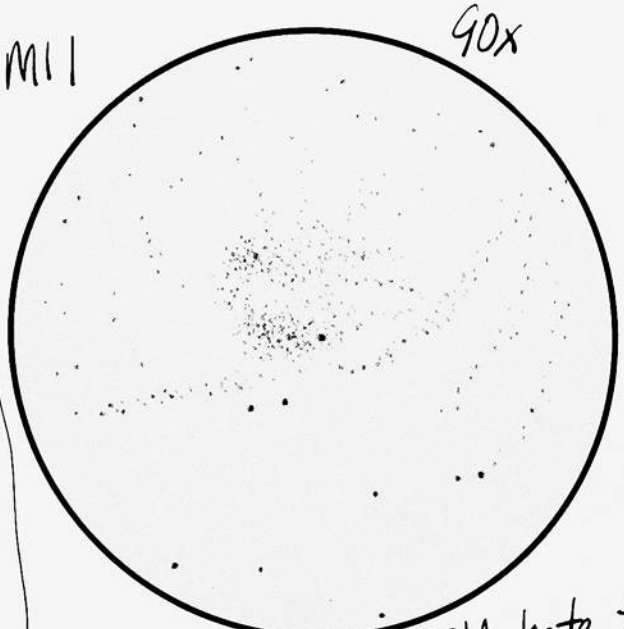
Whirlpool Galaxy in Canes Venatici

M57 90x



The Ring!

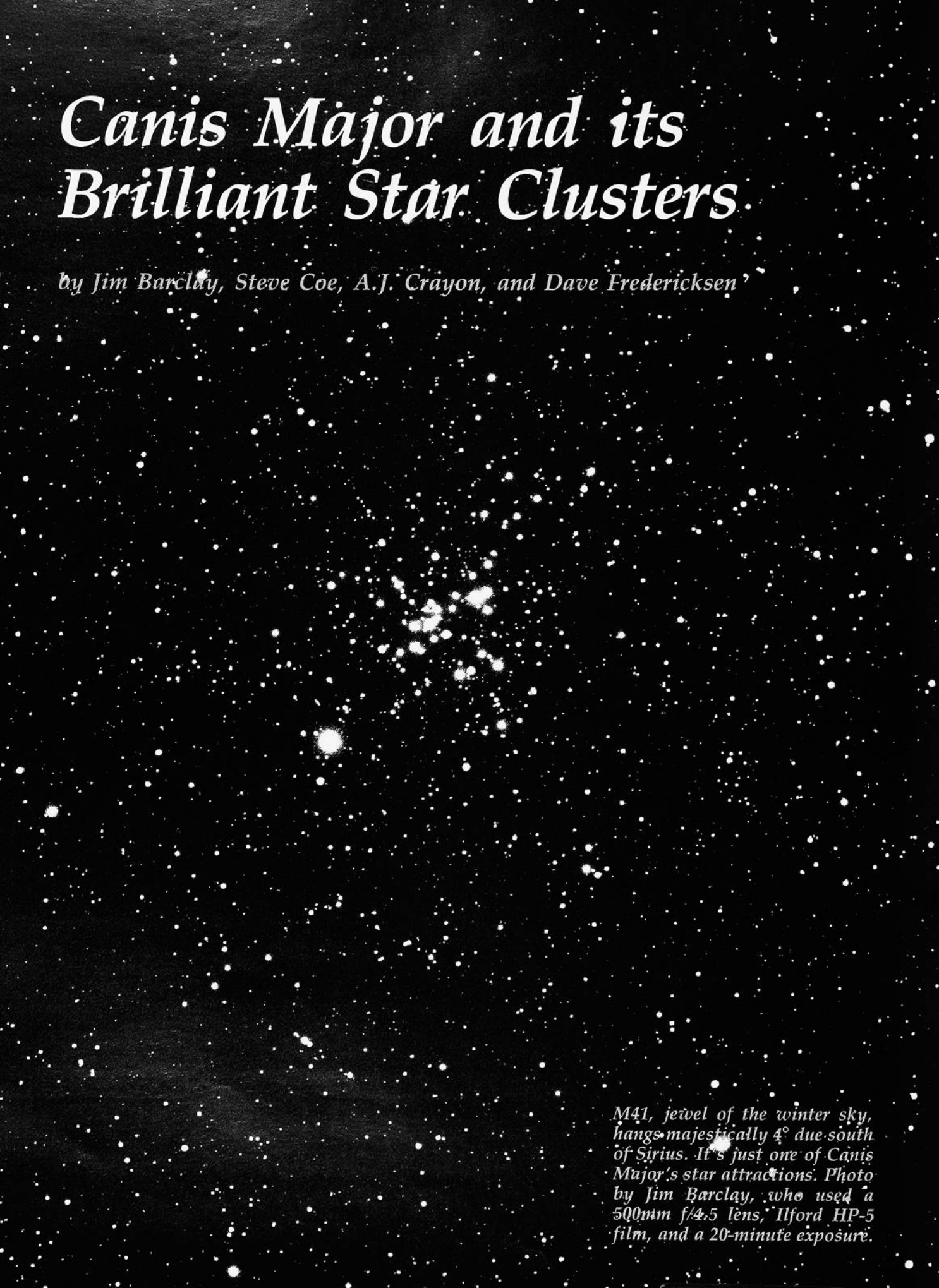
M11 90x



Wild Duck Cluster. I'd hate to count the stars in this field!

Canis Major and its Brilliant Star Clusters

by Jim Barclay, Steve Coe, A.J. Crayon, and Dave Fredericksen



M41, jewel of the winter sky, hangs majestically 4° due south of Sirius. It's just one of Canis Major's star attractions. Photo by Jim Barclay, who used a 500mm f/4.5 lens, Ilford HP-5 film, and a 20-minute exposure.

NGC 2207

12.5-inch f/6 Newtonian
108x

sketch by Dave Fredericksen

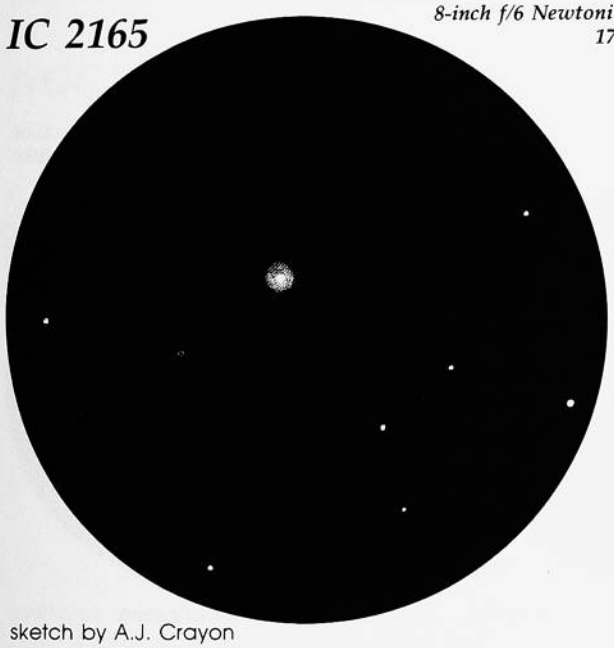
NGC 2217

12.5-inch f/6 Newtonian
108x

sketch by Dave Fredericksen

IC 2165

8-inch f/6 Newtonian
175x



sketch by A.J. Crayon

NGC 2223

17.5-inch f/4.5 Dobsonian
165x

sketch by Steve Coe

The problem with observing Canis Major is that it's always up during the coldest nights imaginable. Mid-winter is the best time to observe this gloriously bright group of stars and as backyard astronomers, I suppose we're more or less duty-bound to dress up warmly and grin and bear it. So when you're out under the stars this winter, look toward Sirius and the rest of Canis Major — you'll see a grand selection of some of the winter sky's best open clusters as well as a handful of other deep-sky treats.

Before describing our observations, here's the lowdown on **Canis Major** itself: the constellation is centered at about 7h and −20°, it covers a sizable 380 square degrees of sky, and it contains the brightest star in the sky — magnitude −1.5 Sirius (Alpha [α] Canis Majoris). Since Canis Major lies along the plane of the bright winter Milky Way, it is strewn with numerous groups of stars, many of which are physical clusters. (Data on 26 open clusters and 21 other objects appears in the table on page 28.) Because many of its clusters are bright, Canis Major is not only a wonderful place to visit with a telescope but also offers good deep-sky viewing to binocular users.

The finest deep-sky object in Canis Major is the large open cluster **Messier 41** (NGC 2287), a collection of some 80 stars spread across a diameter of 38′ — larger than the Full Moon. Lying some 4° due south of Sirius and glowing at magnitude 4.5, M41 is easily a naked-eye object under a dark sky. It's one of the easiest open clusters to find, as all you have to do is scan southward from Sirius and you'll run right into it. In small binoculars it appears as a fuzzy patch of milky light, even under a slightly hazy suburban sky. A 4-inch or 6-inch telescope shows M41 as a scattered grouping of several dozen bright stars and many fainter ones. An 8-inch scope at low power reveals a curious asterism that resembles a question mark.

Beyond M41, Canis Major is rich with other less-known objects. The far western part of the constellation —

NGC 2243

12.4-inch f/6 Newtonian
80x

sketch by Dave Fredericksen

NGC 2280

12.5-inch f/6 Newtonian
108x

sketch by Dave Fredericksen

Sharpless 2-301

12.5-inch f/6 Newtonian
80x + UHC filter

sketch by Chris Schur

Sharpless 2-301

17.5-inch f/4.5 Dobsonian
100x + UHC filter

sketch by Steve Coe

NGC 2354

12.5-inch f/6 Newtonian
108x

Sketch by Dave Fredericksen

away from the plane of the Milky Way — contains not only clusters, but galaxies too. The bright barred spiral **NGC 2207** shines at magnitude 10.7 and measures 4.3′ x 2.9′ across; it is visible with any backyard telescope under a dark sky. Small scopes show NGC 2207 as merely an elongated patch of fuzzy light, while 10-inch or larger instruments reveal a condensed core surrounded by a large, hazy envelope of light. On the western edge of NGC 2207 are two 15th-magnitude stars that are faintly visible using a 12.5-inch scope. Curiously, NGC 2207 lies in a fairly barren field. Nearby is a faint companion galaxy designated **IC 2163**. Can you see the two separate galaxies, or only one distorted blob?

NGC 2206, another barred spiral, is much fainter: it is a 13th-magnitude glow some 2.3′ x 1.4′ across, visible as a nebulous smudge in a 6-inch scope. Another bright barred spiral is **NGC 2217**, which measures 4.8′ x 4.4′ and shines at magnitude 10.4. It appears much the same as NGC 2207, although it is more box-shaped. A 17.5-inch scope faintly shows a central elongation which could be the galaxy's central bar. Two other barred spirals lie in the region: **NGC 2223**, an 11th-magnitude galaxy some 3′ across, and **NGC 2227**, a 14th-magnitude object measuring slightly over 2′ from end to end.

Also in the western part of Canis Major, about 3° southwest of the bright star Beta (β) Canis Majoris, is the bright open cluster **NGC 2204**. Spanning some 13′, NGC 2204 contains 80 stars of magnitudes 12.2 and fainter. This large membership gives it a total magnitude of 8.6 and ensures its visibility in any telescope. A 2.4-inch refractor shows the cluster as a condensed glow of unresolved stars. A 6-incher under a dark sky reveals a clump of faint stars resolved into a peppery haze around the edges. A 10-incher shows a bright orange star on one side of the group and several long chains of stars. A 12.5-inch scope clearly distinguishes about two dozen individual members, with the rest remaining a hazy mass of

M41

8-inch f/6 Newtonian
80x

sketch by A.J. Crayon

NGC 2345

12.5-inch f/6 Newtonian
80x

sketch by Chris Schur

NGC 2360

12.5-inch f/6 Newtonian
108x

sketch by Dave Fredericksen

NGC 2359

12.5-inch f/6 Newtonian
108x

sketch by Dave Fredericksen

NGC 2359

17.5-inch f/4.5 Dobsonian
100x + UHC filter

sketch by Steve Coe

light.

Near the southwestern edge of Canis Major is **NGC 2243**, an exceedingly rich cluster of 100 stars of magnitude 11.8 and fainter. This cluster covers a mere 5′ of sky, but shines with the light of a 9.4 magnitude star. It is an intrinsically large group of stars that appears small because it lies some 4.6 kiloparsecs away; were it closer, NGC 2243 would appear far more impressive. An 8-inch or 10-inch scope shows the cluster as a group of five stars immersed in an unresolved haze. A 12.5-inch scope improves the view considerably, showing at least 20 individual stars. Even in a large telescope, NGC 2243 is so rich that it looks like a loose globular cluster.

Some 8° north of NGC 2243 is the little-known planetary nebula **Perek-Kohoutek 233-16.1**. At about 16th magnitude, PK 233-16.1 is very faint for backyard observers. But it is large enough — some 34″ across — that astrophotographers with long focal length systems may be able to record it successfully. Using a very large telescope, say, a 16-incher or larger, keen-eyed visual observers may even spot it.

Canis Major contains three brilliant Collinder open clusters — large groups of stars which make perfect binocular targets. **Collinder 121** lies in central Canis Major in a field containing Omicron[1] (o^1) Canis Majoris and the bright variable EZ Canis Majoris. The cluster's total magnitude is 2.6 and it covers nearly a degree of sky — see if your binoculars show all 20 stars, the brightest of which is a 4th-magnitude object. The southeastern corner of the constellation holds two more large bright clusters. **Collinder 132** contains 25 stars in a diameter some 95′ across — the brightest is a magnitude 5.3 star; the cluster's total magnitude is 3.6. **Collinder 140** is smaller but equally as bright: its 30 stars cover 42′ of sky and have a combined magnitude of 3.5.

North of Collinder 132 and 140 are a whole series of deep-sky objects lining Canis Major's eastern border with Puppis. One-and-a-half degrees north-

Deep Sky Objects in Canis Major

Object	Type	R.A.(2000)Dec.	Mag.	Mag.★	N★	Size/Sep./Per.	P.A.	Distance	Diameter
NGC 2204	⊙	6h15.7m −18°39′	8.6	12.2	80	13′	—	4.5 kpc	17 pc
NGC 2206	SAB(rs)bc	6h16.0m −26°46′	13:p	—	—	2.3′x1.4′	—	80 Mpc	55 kpc
NGC 2207	SAB(rs)bc pec.	6h16.4m −21°22′	10.7	—	—	4.3′x2.9′	—	30 Mpc	40 kpc
NGC 2217	(R)SBO^{+}	6h21.7m −27°14′	10.4	—	—	4.8′x4.4′	—	16.5 Mpc	25 kpc
IC 2165	■	6h21.7m −12°59′	12.9p	15.9	—	4″	—	3.1 kpc	23 kpc
Beta (β)	SV	6h22.7m −17°57′	1.9↔2.0	—	—	0.25d	—	230 pc	—
NGC 2223	SAB(r)b	6h24.6m −22°50′	11.4	—	—	3.3′x3.0′	—	30 Mpc	30 kpc
NGC 2227	SB(rs)cd	6h25.9m −21°59′	14:p	—	—	2.3′x1.2′	—	25 Mpc	16 kpc
PK 233-16.1	■	6h27.0m −25°23′	16.3p	15.4	—	34″	—	3.7 kpc	0.5 pc
NGC 2243	⊙	6h29.8m −31°17′	9.4	11.8	100	5′	—	4.6 kpc	6.6 pc
Ruprecht 1	⊙	6h36.4m −14°11′	—	11p	15	11′	—	—	—
Ruprecht 2	⊙	6h41.0m −29°33′	—	12p	10	7′	—	—	—
Ruprecht 3	⊙	6h42.1m −29°27′	—	11p	15	2.8′	—	—	—
NGC 2272	SA0^{-}	6h42.7m −27°27′	11.9	—	—	2.1′x1.6′	—	—	—
NGC 2280	SA(s)cd	6h44.8m −27°38′	11.8_B	—	—	5.6′x3.2′	—	22 Mpc	35 kpc
Alpha (α)	★^{2}	6h45.1m −16°43′	−1.5,8.5	—	—	10.8″	72°	2.67 pc	—
M41(NGC 2287)	⊙	6h47.0m −20°44′	4.5	6.9	80	38′	—	0.7 kpc	7.7 pc
Collinder 121	⊙	6h54.2m −24°38′	2.6	3.8	20	50′	—	0.7 kpc	10.2 pc
Epsilon (ε)	★^{2}	6h58.6m −28°58′	1.5,7.4	—	—	7.5″	161°	208 pc	—
Cederblad 90	□ER	7h05.2m −12°20′	—	8.5	—	10′x10′	—	—	—
Ruprecht 11	⊙	7h07.4m −20°48′	—	11p	20	2.9′	—	—	—
NGC 2345	⊙	7h08.3m −13°10′	7.7	9.9	70	12′	—	1.8 kpc	6.2 pc
Haffner 23	⊙	7h09.4m −16°57′	—	13p	40	11′	—	—	—
Sharpless 2-301	□E	7h09.8m −18°29′	—	10	—	8′x7′	—	—	—
NGC 2354	⊙	7h14.3m −25°44′	6.5	9.1	100	20′	—	1.9 kpc	11.1 pc
Collinder 132	⊙	7h14.4m −31°10′	3.6	5.3	25	95′	—	—	—
RY	CV	7h16.6m −11°29′	7.7↔8.5	—	—	4.67d	—	—	—
Basel 11A	⊙	7h17.1m −13°58′	8.2	10.9	30	9′	—	1.5 kpc	3.9 pc
IC 468	□E	7h17.5m −13°09′	—	—	—	20′x20′	—	—	—
NGC 2360	⊙	7h17.8m −15°37′	7.2	10.4	80	13′	—	1.6 kpc	6.1 pc
NGC 2359	□E	7h18.6m −13°12′	—	—	—	8′x6′	—	—	—
UW	EV	7h18.7m −24°34′	4.8↔5.3	—	—	4.39d	—	1.1 kpc	—
NGC 2362	⊙	7h18.7m −24°34′	4.1	4.4	60	8′	—	1.6 kpc	3.7 pc
R	EV	7h18.8m −24°57′	5.7↔6.3	—	—	1.14d	—	—	—
van den Bergh 96	□R	7h19.6m −16°24′	—	9.2	—	10′x5′	—	—	—
Haffner 6	⊙	7h20.1m −13°08′	9.2	11.1	60	4′	—	1.1 kpc	1.2 pc
NGC 2367	⊙	7h20.1m −21°56′	7.9	9.4	30	3.5′	—	2.0 kpc	2.0 pc
T	SRV	7h21.4m −25°27′	9.0↔11	—	—	309d	—	—	—
Ruprect 16	⊙	7h23.2m −19°57′	—	13p	15	11′	—	—	—
Haffner 8	⊙	7h23.4m −12°20′	9.1	11.1	30	4.2′	—	1.7 kpc	2.1 pc
Collinder 140	⊙	7h23.9m −32°12′	3.5	5.4	30	42′	—	0.3 kpc	3.7 pc
NGC 2374	⊙	7h24.0m −13°16′	8.0	10.8	25	19′	—	1.3 kpc	7.2 pc
NGC 2383	⊙	7h24.8m −20°56′	8.4:	9.8	40	6′	—	2.0 kpc	3.5 pc
Ruprecht 18	⊙	7h24.8m −26°13′	9.4	11.0	40	4′	—	—	—
NGC 2384	⊙	7h25.1m −21°02′	7.4:	8.6	15	2.5′	—	2.0 kpc	1.5 pc
Trumpler 6	⊙	7h26.1m −24°18′	10.0_B	—	—	6′	—	—	—
Ruprecht 20	⊙	7h26.7m −28°53′	9.5	11.6	30	10′	—	—	—

Column 1: object name in *Revised New General Catalogue*, by J. Sulentic and W. Tifft, University of Arizona Press, 1973, *Index Catalogue* by J.L.E. Dreyer, Royal Astronomical Society of London, 1971, and various other lists. **Column 2:** object type: ★^{2} = double star; SRV = semiregular variable; EV = eclipsing variable; CV = Cepheid variable; SV = spectrum variable; ⊙ = open star cluster; ■ = planetary nebula; □E = emission nebula; □R = reflection nebula, revised Hubble types given for galaxies. **Column 3:** coordinates for epoch 2000.0. **Column 4:** total V magnitude unless subscript p (photographic) or B (blue). **Column 5:** magnitude of central star or brightest cluster member. **Column 6:** number of stars in cluster. **Column 7:** size in arcminutes or arcseconds, separation of double star in arcseconds, or period of variable in days. **Column 8:** position angle for double stars. **Column 9:** distance in parsecs, kiloparsecs, or megaparsecs. **Column 10:** diameter in parsecs or kiloparsecs. Data for stars from *Yale Catalogue of Bright Stars*, 4th ed., by D. Hoffleit, Yale University Press, 1982. Data for open clusters from B. Skiff, Lowell Observatory, 1983. Data for galaxies from *Second Reference Catalogue of Bright Galaxies*, by G. de Vaucouleurs, A. de Vaucouleurs, and H. Corwin, University of Texas Press, 1976. Compiled by D. Eicher.

east of the bright star Eta (η) Canis Majoris is the open cluster **Ruprecht 20**. With a total magnitude of 9.5, this group of 30 stars is visible as a nebulous knot in a 2-inch scope. A larger telescope shows several individual stars, the brightest being of 11.6 magnitude, in a hazy spot of nebulosity some 10′ across. Three degrees north is **Ruprecht 18**, a similarly-bright cluster which is more compact. Ru 18 spans only 4′ across and contains 40 stars of 11th magnitude and fainter. Its integrated magnitude is 9.4. Another 2° north is the diminutive cluster **Trumpler 6**, a 10th-magnitude group of stars measuring some 6′ across.

Northeast of the bright star Delta (δ) Canis Majoris are two brilliant NGC clusters. The best, **NGC 2362**, is a rich group of 60 stars surrounding the 4.4 magnitude star Tau (τ) Canis Majoris. The cluster's total magnitude is 4.1, making it visible as a starlike naked-eye object under a dark sky. As NGC 2362 measures only 8′ across, it appears highly condensed in small telescopes that show it as a clump of tiny pinpoints surrounding the brilliant star Tau. Astronomers believe that Tau may indeed be a member; if so — at a distance of 1.6 kiloparsecs — Tau would be one of the Galaxy's more luminous stars. Tau CMa is a triple star, easily split with an 8-inch scope at 100x.

Midway between NGC 2362 and Delta CMa is the fine open cluster **NGC 2354**. This is a rather large, exceedingly rich group, one containing 100 stars in an area some 20′ in diameter. The brightest stars in NGC 2354 are 9th-magnitude objects; the group's total magnitude is 6.5, making it easily visible as a hazy cloud in binoculars.

Northeast of NGC 2362 is a small reflection nebula designated **van den Bergh 96**. This object is a faint cloud of dust particles measuring 10′ x 5′, which is centered on a 9th magnitude illuminating star. This object is so faint that a 17.5-inch reflector, with and without a UHC filter, failed to show any trace of it.

The northeast quadrant of Canis Major contains additional examples of bright clusters and faint nebulae. **NGC 2383** is an 8th-magnitude group of 40 stars packed into 6′ of sky. It lies in such a rich field of Milky Way stars that the cluster itself appears as a brightening in the overall background of stars. In the same field of view is **NGC 2384**, a 7th-magnitude knot of 15 stars some 2.5′ across shaped in a butterfly pattern. These two groups are *not* the most impressive objects in Canis Major! About 2° north of this field is **Ruprecht 16**, a sparse cluster covering 11′ and containing 15 faint stars.

NGC 2362

12.5-inch f/6 Newtonian
108x

sketch by Dave Fredericksen

NGC 2362

8-inch f/6 Newtonian
115x

sketch by A.J. Crayon

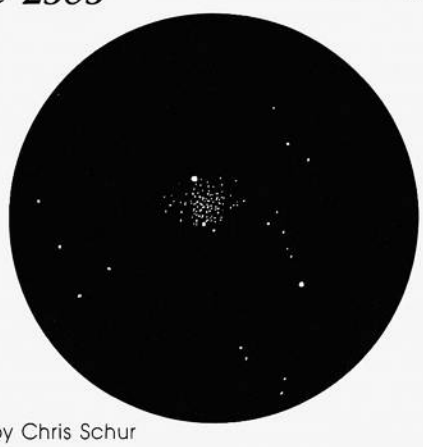
NGC 2374

12.5-inch f/6 Newtonian
80x

sketch by Chris Schur

NGC 2383

12.5-inch f/6 Newtonian
80x



sketch by Chris Schur

Star cluster **NGC 2360** is a fine object for binoculars or small scopes: it measures 13′ across and contains 80 stars. A finderscope shows NGC 2360 as a bright glow in a rich section of the Milky Way. The brightest stars in this group are bluish-white and yellow, and shine at 8th magnitude. Another fine cluster is **NGC 2374**, located 4° west of the brilliant clusters M46 and M47 in Puppis. NGC 2374 is an 8th-magnitude group of 25 stars, which individually measure 11th magnitude and fainter. An 8-inch scope shows 20 stars blending into faint background haze. Larger telescopes only seem to make this cluster blend in more with the rich background.

Two unusual emission nebulae visible in large backyard telescopes are **NGC 2359** and **IC 468**. These objects probably require at least a 6-inch scope under a dark sky, but reliable reports come from observers who have spotted them with a 3-inch scope. Although the surface brightness varies widely over the face of the two objects, the overall dimensions are 20′ x 20′ for IC 468 and 8′x 6′ for NGC 2359. The two overlap, resulting in a dim amorphous glow visible in an 8-inch scope at 100x. A 12.5-inch scope with a UHC filter reveals several stars within the nebulosity. A 17.5-inch telescope makes a big difference: the nebulosity is much brighter and faint wisps extend out of a 30′ field of view. Can you spot this elusive system of nebulae?

Let's finish the survey of Canis Major with the brightest star in the sky, **Sirius** (Alpha [α] Canis Majoris). At a distance of 2.67 parsecs — about 52 trillion miles — it's easy to see why Sirius appears so bright: it's so very close to us in the Galaxy. Actually many stars are intrinsically brighter than Sirius. Yet, known as the Dog Star, it's fascinated watchers of the sky for millenia. Only a century ago did astronomers find that Sirius is more than a magnitude −1.5 type A1 main sequence star, meaning it's a *double* star; curiously, the faint companion is a white dwarf. Observers have long considered a successful observation of Sirius B, the magnitude 8.5 white dwarf (10.2″ from Sirius at p.a. 72″), a test of keen observing. Can you spot the little star basking in the brilliant glare of our sky's brightest star?

Jim Barclay is an avid observer, astrophotographer, and astronomy popularizer in Queensland, Australia. Steve Coe, A.J. Crayon, and Dave Fredericksen are members of the Saguaro Astronomy Club in Phoenix, Arizona.

DSM Reports

The Night I Saw Kohoutek 1-20

by Jack Marling

On August 11th, I decided to go deep-sky observing with my friends Bill Faatz and Steve Gottlieb. After some deliberation, we headed off to one of our favorite dark-sky sites near Digger Pines, California. We're a triad of what some people might call hardcore deep-sky observers and we had decided to observe something really exotic.

After we got to the site and started observing, Bill began exclaiming how nice some bright globular cluster appeared in his 12.5-inch scope. I was using the Tri-Valley Stargazers' 17.5-inch reflector to observe a little-known planetary nebula called DHW 3, named after the astronomers Dengle, Hartl, and Weinberger who discovered it in 1980. DHW 3 is a 30″ diameter planetary glowing dimly at photographic magnitude 15.6. I called out to Bill, asking him whether he'd like to see a nice planetary. Maybe he expected an M76 or an NGC 246 because when he peered into the 13mm TeleVue eyepiece, all he said was: "Where is it?" (The field was so large you could get lost in it.)

"Just west of those two bright stars," I responded.

Bill spotted it then, but wasn't impressed. I informed him that we may be the first people to observe this dim planetary visually, and we were only seeing it because we had a large telescope and an oxygen-III filter I had designed several months earlier.

Just then Steve, who had been looking at southern galaxies with his 13.1-inch scope, came by to see what sort of planetary was causing all this fuss. Steve looked into the eyepiece and was nonplussed: "Yeah, there it is. Not hard at all with averted vision." Bill observed it again and added, "I agree; it's not hard to see at all! Why don't you try for a *really* faint planetary, Jack?"

Back at home, while working on a book project about some 600 planetary nebulae, I thought about the faintest possible planetaries one could observe with a backyard telescope. During the last 10 years, knowledge about the brightnesses of planetaries has increased tremendously: many planetaries have recently been studied by astronomers using sensitive photometers to measure flux at various discrete spectral emission lines, such as the blue-green hydrogen-beta line or the two doubly-ionized oxygen lines.

From these data I have calculated true visual magnitudes of various planetaries by relating the photometric data with the spectral response of the dark-adapted human eye.

Muttering "I'll show you," I chose a really faint planetary called Kohoutek 1-20, located 5° northeast of the bright planetary NGC 7662 in Andromeda. Lubos Kohoutek, who discovered this object in 1963, lists K1-20 at photographic magnitude 16.4. Based on more modern but sketchy photometry, I estimated its visual magnitude to be between 15.6 and 18.8, depending on the actual strength of the unmeasured oxygen-III nebula lines. I began preparations in earnest.

First I had to prepare physiologically. Somewhere I had read that taking vitamin E would help increase eye sensitivity to faint light if coupled with wearing dark glasses. I had been taking 200 I.U.'s of vitamin E daily since June and wore dark glasses every time I went outdoors. I also made sure my daily multivitamin supplement contained vitamin A, which is necessary for creating the visual purple used in night vision. However, vitamins A and E are both oil soluble rather than water soluble and are therefore stored by one's body — I had to be careful not to take too much of either one to avoid a toxic buildup.

Next I had to prepare for finding and identifying K1-20. First I plotted it on *Sky Atlas 2000.0*, marking its position in ink. It lies at 23h 39.2m, +48° 12.6′ (2000), about 1½° southeast of the magnitude 5.6 open cluster NGC 7686. I also noted a star on the atlas just north of K1-20. After checking the star's position, I knew that K1-20 was located exactly 47 arcminutes south and 12 arcminutes east of a 7.1 magnitude field star. Normally this information is adequate to center an obscure object in an eyepiece if you know the true field of view of various eyepieces. For example, the TeleVue 24mm eyepiece has a true field of view of 47 arcminutes on the 17.5-inch f/4.5 telescope. The plan would be to find the 7.1 magnitude star, easily visible in the finderscope, then move exactly one eyepiece field south from the star, and one-fourth of one field east.

However, this time I would need some extra help so I made a copy of finder chart #FC455 from the *Catalogue of True and Possible Central Stars of Planetary Nebulae* by Acket *et al.* K1-20 has a 20th magnitude central star that I'd never see, but its inclusion in the catalogue meant there was a finder chart available. I could now spot the *exact* location of K1-20 — would it be visible?

On Saturday, August 24, my wife Nancy and I went to Digger Pines. Upon getting there, I went right to sleep: this would give me in effect hours of dark adaptation and well-rested eyes. When I finally got up, the sky was stunningly bright — "Oh no, I've overslept until dawn!"

But I hadn't: the brilliant Milky Way overhead convinced me that it was still the middle of the night and I could look for the faintest planetary I'd ever observed. Grabbing my notes and finder charts, I quickly found the 7.1 magnitude field star and, using the 24mm eyepiece, centered the area containing Kohoutek 1-20 in the field. I attached an oxygen-III filter, which transmits only the OIII lines at 496 nanometers and 501nm with an 11nm bandpass. I also placed a black cloth over my head.

I looked into the eyepiece carefully, but didn't see a thing! I checked a map. There was no doubt about it — I was looking at the exact location but couldn't see anything. Next I switched to a 13mm Nagler to darken the sky by going to a higher power; at 150x with the OIII filter the sky was absolutely pitch black, but still I saw nothing. The last trick up my sleeve was eating a snack. After having some fruit and waiting several minutes, I tried again. Again, nothing — even with averted vision. Finally I tried "long integration" — averted vision by looking at spots above, below, and alongside the hopeful spot for 5 to 10 seconds each. Was something just lurking there with "averted imagination"?

YES! The more I looked, the more the impression strengthened. Finally I was able to perceive obscure Kohoutek 1-20 with averted vision.

Epilogue: That same night, as a warmup to looking for K1-20, I observed seven other obscure planetaries but failed to see four others. Although K1-20 may not be visible using anything less than an 18-inch or larger scope and filters, the recently-discovered planetary DHW3 should be visible in 10-inch and larger scopes. It is located in Sagittarius at 19h 17.10, −18° 01.6 (2000.0) just 10 arcminutes southwest from an 8th magnitude star plotted on Tirion's atlas.

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Plotting the RNGC, Part 1

by Richard Berry

Have you ever wondered how the sky would look if you could see the star clusters, nebulae, and galaxies at a glance? Well, I got to wondering about that, too. And not only did I wonder, but as you will see on the following two pages, I did something about it. The swarm of dots shown there is the sky without stars, but with all of the objects — each represented as a single dot — listed in the *Revised New General Catalogue* (Sulentic and Tifft, University of Arizona Press, 1973) plotted on it. I hope it'll provide a new and exciting view of the sky to all but the most jaded deep-sky observers.

The story behind our RNGC all-sky chart goes back several years, when we first started plotting star maps here at AstroMedia. Soon we were running maps in ASTRONOMY (and *Deep Sky*, too!) based on the *Yale Bright Star Catalog*, a database of 9,100-some stars down to visual magnitude 6.5. We obtained the database from Wayne Warren of the National Space Science Data Center, and the travail I endured getting the data off a 9-track tape and onto the 5¼" DS DD 16 hard-sector diskettes our computers use is a story in itself. Suffice it to say that the job ultimately involved five medium-to-medium transfers.

Eventually we realized that the Dreyer NGC catalog — more properly, Sulentic and Tifft's RNGC — lay in our future. However, we needed the database in machine-readable format and, most unfortunately, several of the people who helped us do the YBS transfer had left town so we couldn't order a tape and transfer it to floppies as easily as we had before. Luckily, we were able to obtain a copy of the RNGC from Barry Rappaport at JPL (and wish to take this opportunity to thank him for sharing his data files with us).

This chart was run using MAPMAKER software that I developed for plotting star maps. The chart itself is a simple equidistant cylindrical projection, in which right ascension and declination are plotted on a grid with equal spacing. Obviously, distortion will increase rapidly toward the poles in this projection, but we can partially offset that by squeezing the right ascension scale. For this chart, distortion is compensated at +30° and −30° declination. Regions nearer the equator are compressed; those farther away are stretched.

I plotted every object in the RNGC using the catalogue magnitude to control the dot size. There are problems with this procedure, however, because RNGC magnitudes are unreliable, inconsistent, or entirely absent for a large number of objects. There isn't much to be done about the quality of the database and, in any case, half-magnitude accuracy is good enough to see general trends over the entire sky. For those objects having no data, I simply plotted the smallest dot size and left it at that. (This is an important point to remember because the RNGC does not assign magnitudes to nebulae. Almost all nebulae are, therefore, plotted as tiny dots.)

The most obvious features of the plot are the grand sinusoidal great circle of the Milky Way, evidenced by numerous bright open clusters, and the more subtle north-south axis of the local supergalaxy between 12 and 13 hours with the Virgo Cluster at its center. This first feature is expected, indeed, it shows up in plots of the *Bright Star Catalog*, too. The second is less expected. Consider that the NGC's sources date back to visual sweeps of the sky made by William Herschel in the 18th century, collected and extended to the southern hemisphere by his son John, as the General Catalogue (GC). Finding the plane of the supergalaxy so obviously in a simple plot of this largely two-century-old visual data is quite a surprise. I wonder if the Herschels would have discovered the supergalaxy if they'd plotted all the objects in their GC.

Also evident is the gross disparity between the average brightness of galactic and extragalactic objects, and also the near-total absence of extragalactic objects near the plane of the Milky Way. Obscuration in the plane of the Galaxy explains the latter, of course, but the cause of the former is unclear. While the intrinsic brightness and distance of galaxies may explain the absence of bright galaxies, it's less obvious why there are few faint open clusters. Is this real (there are few faint open clusters) or a selection effect (i.e., faint open clusters exist, but they are not seen in rich Milky Way starfields)? We'll leave this as an exercise for the readers.

It's also interesting to note a certain "stringiness" in the surface distribution of galaxies. While we aren't presenting a million galaxies here (as the famous plot by Peebles does), the 6,000 or so galaxies we do show exhibit the same phenomenon, or at least it looks to me like they do. "Plotting the RNGC, Part 2" and "Part 3" in *Deep Sky* 14 and 15 will show the northern and southern galactic hemispheres in better detail, so you can decide for yourself.

Now let's get down to looking at this thing in detail and gently elucidate a couple of *caveats* on using the RNGC database. Grab your favorite big star atlas to help you navigate, turn to Chart 1 (or whatever shows Cassiopeia), and find the Double Cluster. It appears on our chart as a biggish double dot. As a test of your ability to orient yourself, can you find NGC 654, NGC 659, and NGC 663? (Hint: they form a little L-shaped blob on the plot. When comparing, remember that shapes are somewhat distorted on our plot this far north.) Notice that all IC objects are absent, as are Trumpler, Collinder, and Melotte clusters. Hmmm. Well, this is the RNGC, the whole RNGC, and nothin' but the RNGC.

Where's Orion? Isn't that full of good stuff? It is actually quite difficult to find because many of the Orion objects aren't assigned magnitudes in the RNGC. The big dot at 5h 34m −6° is NGC 1980 — a cluster — and all the rest of the Orion stuff, including the Great Nebula, are tiny dots because the RNGC doesn't give magnitudes for nebulae. By contrast, the little swarm of galaxies in northeastern Eridanus is quite obvious.

There's an interesting region around 4h 00m +30°, a region of almost blank sky. That's galactic absorbtion, you say. Taurus is full of it. So it is, for there are no galaxies in that region. But look more carefully and you'll see a dozen or so tiny dots in there, one of which is NGC 1499 — the California Nebula.

Next inspect that heavy concentration of clusters running through Canis Major and Puppis. This time I'm not pulling a fast one on you — there are a lot of open clusters in this region. The galactic center region abounds in clusters too, both open and globular. Nebulae, of course, show up as tiny dots.

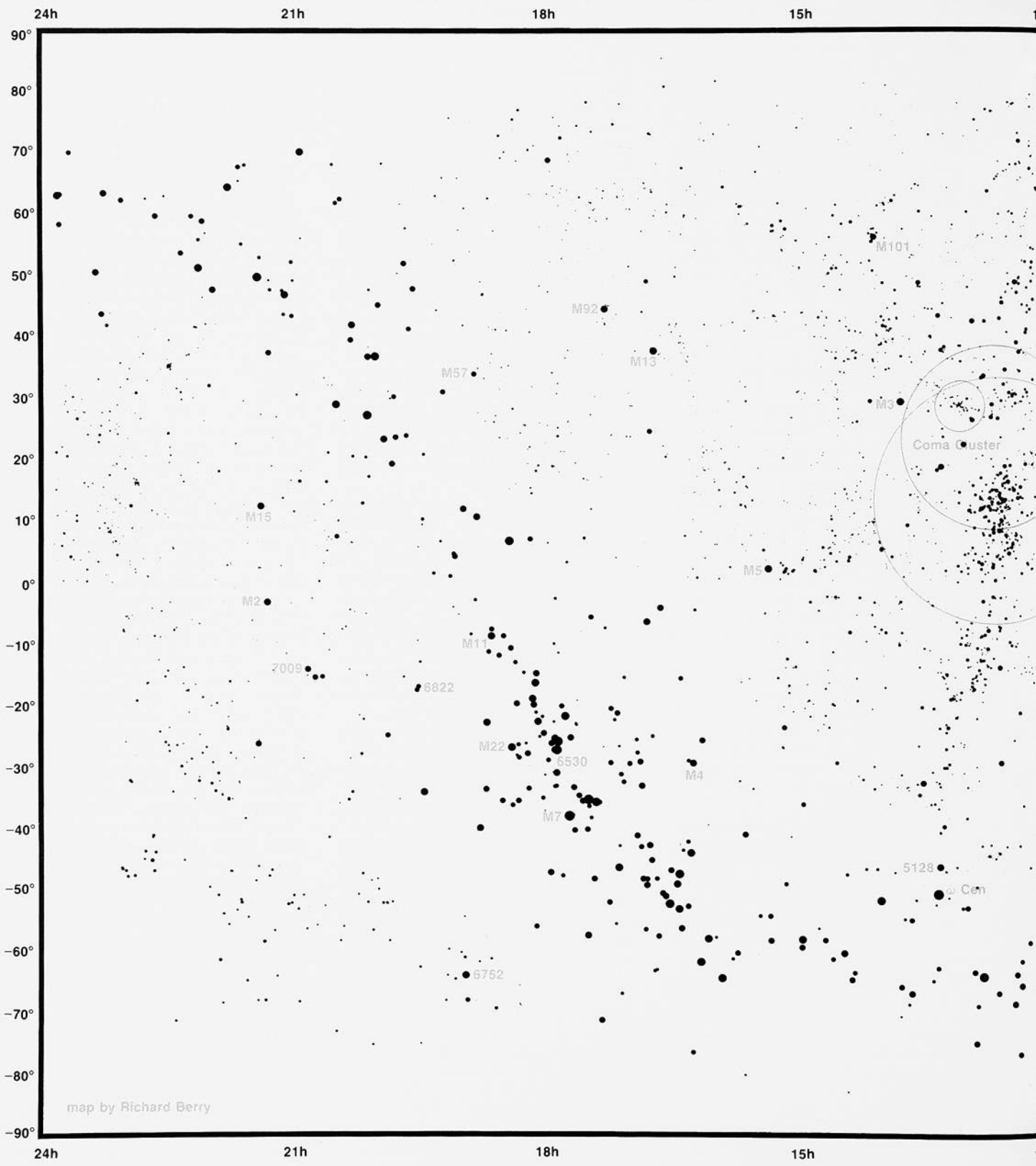
Here's something to try: infer the distribution of absorbing material in the Galaxy by the obscuration of background galaxies. The plot won't tell you directly which dots are faint galaxies and which are nebulae, but with the aid of your handy-dandy star atlas, you can double check. To a good approximation, though, nebulae stick close to the galactic plane while galaxies shun it.

Just a word on galaxies: we're saving the good stuff for the next installment. M31 is the big obvious dot at the extreme right of the plot. The Virgo Cloud is the conspicuous cluster slightly above center, located on 12h 30m.

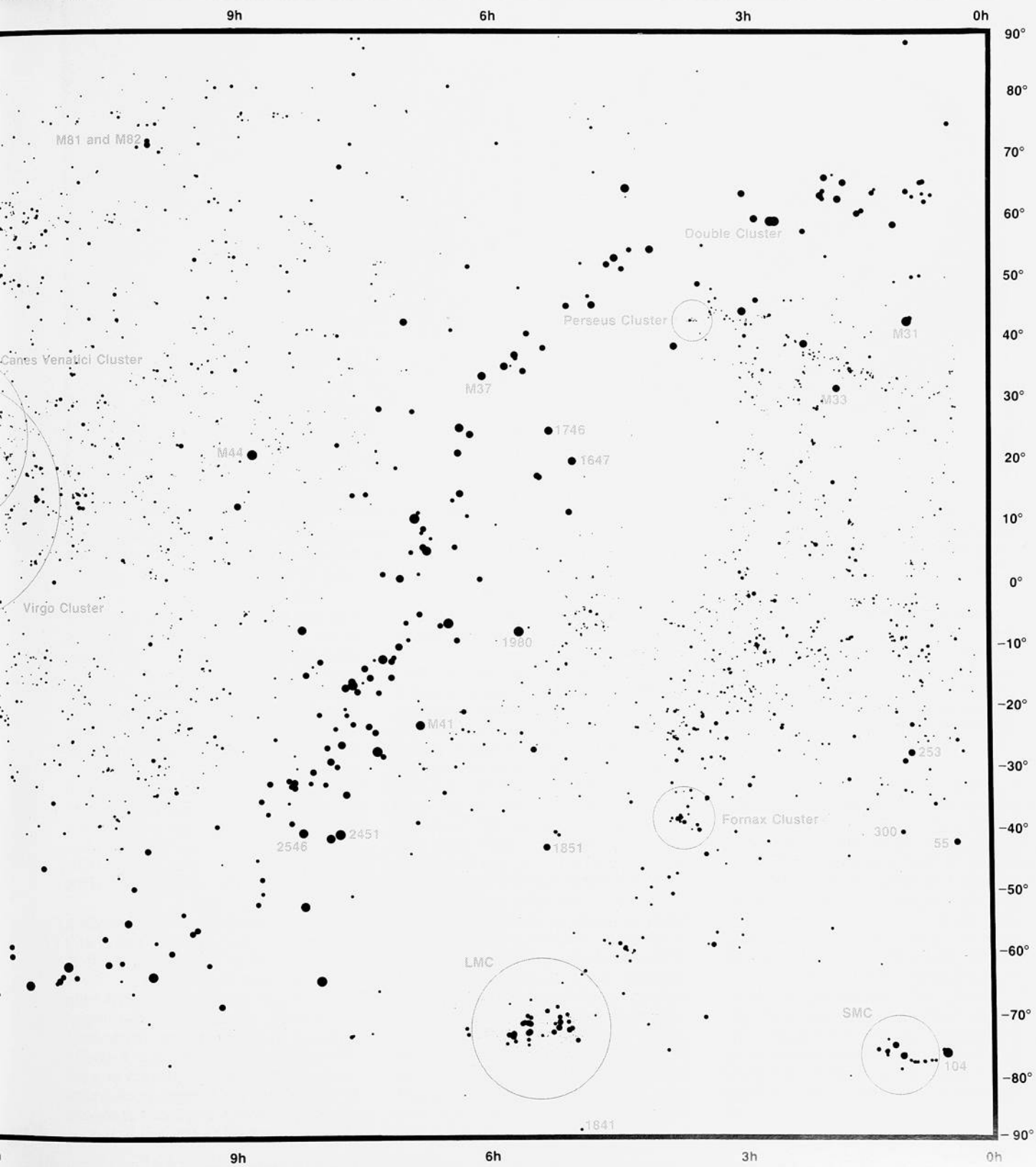
To the right of the Virgo Cloud is the loose group of brightish galaxies in Leo, including M65, M66, M95, and M95. North of the Virgo Cloud and veering westward are the rich galaxy fields of Ursa Major, Canes Venatici, and Coma. I was rather surprised to see that the Coma Cluster of galaxies is more obvious on our plot than it is on a big star atlas. *Sky Atlas 2000.0* shows only NGC 4793, NGC 4872, NGC 4874, and NGC 4889; our chart shows at least a dozen cluster members.

I hope you have as much fun exploring the NGC as I did. We'll be back in the next issue with the galaxies of the north galactic pole.

The Revised New General Catalog of



Nonstellar Astronomical Objects



DSM Reviews

Halton C. Arp

A 5-meter Hale telescope shot showing NGC 1097's outer jets and halo. Inset shows inner detail including galaxy's spiral arms.

Halton C. Arp

A photo made with Palomar's 1.2-meter Schmidt shows NGC 1073 and the three quasars near its arms — coincidence?

Enhanced Images of Active Galaxies
Halton C. Arp
20 slides and booklet, $16.95
Astronomical Society of the Pacific (1982)
[publisher's address: 1290 24th Ave., San Francisco, CA 94122]

During the past few years, a whole community of astronomers has arisen to interpret "active" galaxies. Active galaxies are those which show some sort of abnormal energetic activity — whether it be the ultraviolet emission of a Seyfert nucleus, the highly-ionized jet emanating from M87's core, or a trio of quasars coincidentally surrounding galaxy NGC 520. It's no surprise that there is a lot of interest in active galaxies — clearly they hold several mysteries which, if solved, would shed more light on understanding the universe. The surprise of the last decade is that many professional astronomers have aligned themselves with one of two political factions; the minority group believes that certain associations of active galaxies prove redshifts inaccurate as distance indicators. The majority believes the objects are unassociated and redshifts are reliable measurements of extragalactic distances.

I was slightly worried that the ASP's slide set *Enhanced Images of Active Galaxies* wouldn't pull off the difficult job of keeping a balanced view of this controversial aspect of active galaxy research. I shouldn't have worried: the slide set, assembled by Mt. Wilson's Halton C. Arp, is one of the most interesting products for deep-sky observers that the ASP has ever produced. (Arp, by the way, belongs to the "discordant redshift" minority.)

The set contains 20 slides, most of them black and white negatives, which successfully illustrate the various types of active galaxies grabbing most of the attention these days. Arp begins by looking at M87, whose jet of high-velocity gas was first photographed by Heber Curtis in 1918. Also shown is NGC 1097 in Fornax, whose far dimmer jet of material was discovered decades later. There's a color multiple image of NGC 1097's jet, made with the 5-meter scope on Palomar Mountain, that looks like pretty high-tech pop art.

The coverage then moves on to NGC 520 and three quasars that happen to lie in the same field of view — a statistical near-impossibility by chance. Are the quasars aligned with the galaxy? Are their redshifts, which indicate a far greater distance, incorrect? Are quasars close objects that are expelled from galactic nuclei at high speed?

Also discussed and supplemented with fine images — made with either the 5-meter Hale telescope or Palomar's 1.2-meter Schmidt — are M81 and M82, Stephan's Quintet, NGC 4151, NGC 7603, NGC 7171, NGC 5689, NGC 5296, and NGC 1073.

Happily, the slide set isn't merely a discussion of just one side, and it isn't a textbook either. Viewers are left to draw their own conclusions.

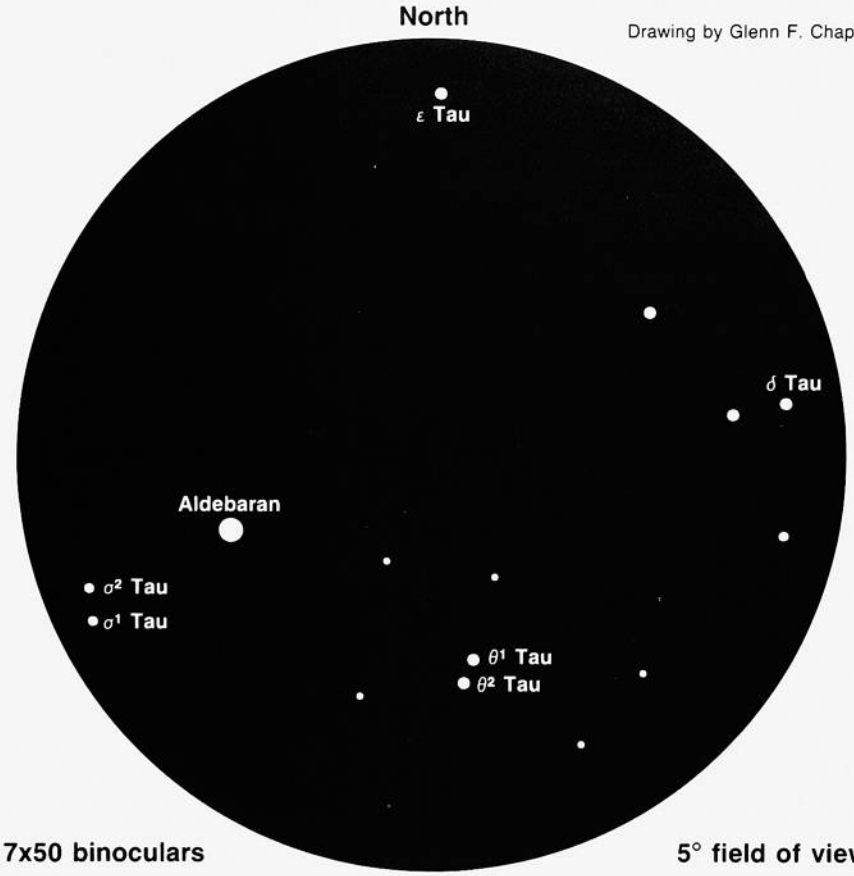
I'm happy to see the ASP producing slide sets on current, meaningful subjects in observational astronomy. The sets aren't cheap, but if you're really into galaxies or quasars or want to build a library of images for club slide shows, you owe it to yourself to acquire *Enhanced Images of Active Galaxies.* —

David J. Eicher.

Double Stars

The Eye of the Bull

by Glenn F. Chaple



I dunno.

Maybe I'm being pessimistic, but I'm not sure I should put together a column for this issue of *Deep Sky*. Halley's Comet is visiting the night sky for the first time in three-quarters of a century, and I wonder how many telescope owners are going to bother with a bunch of double stars.

Of course, Halley is lost in the Sun's glare for about a month from late January to late February. Maybe I could serve up a list of double stars to help tide things over while everyone awaits the comet's reappearance. So be it! There *will* be a double star column in this issue of *DSM*! (All right, all right — you can stop the wild applause.)

Let's zoom in on the Hyades cluster — that prominent V-shaped star group that outlines the head of Taurus the Bull. Because of its large size, the Hyades isn't a very interesting telescopic sight. Binoculars offer a much better view. But since it's double stars we're after our telescopes will get a good workout.

Let's start with Aldebaran. This ruddy first-magnitude star forms an appropriately baleful Bull's eye. Aldebaran only pretends to be one of the Hyades, however. At a distance of about 70 light-years, it lies roughly midway between us and the cluster.

About 120 arc seconds from Aldebaran is an 11th magnitude star. Such a wide gap belies the difficulty you'll have finding this companion: it isn't always easy to ferret it out of Aldebaran's glare. I've never seen it with my 3-inch reflector, and am comforted somewhat by T.W. Webb's comment that it forms a light test for small aperture telescopes. The little star is only an optical companion to Aldebaran — the two are slowly drifting apart.

In the last column we looked at the early 19th century astronomer F.G.W. Struve and his catalog of over 3000 double stars. I mentioned that Struve generally omitted pairs separated by more than 32 arc seconds. Actually, he didn't completely ignore those spectacular wide doubles like Albireo and ν Draconis — he banished them to an appendix of the main catalog. Aldebaran and its optical partner found their way into Struve's second appendix and are catalogued there as ΣII 2.

In 1888, Aldebaran came under the scutiny of the eagle-eyed astronomer S.W. Burnham. Not only did he see the faint companion, but he resolved it into two stars! The companion's secondary, of magnitude 13.4, was just 2.3″ away at the time. This pair, catalogued as β1031, appears to be physically bound and has closed somewhat during the past century.

There is another star that Aldebaran apparently holds fast in its gravitational grasp. It shines feebly at magnitude 13.5, a scant 30″ away. Guess who discovered it. Here's a clue — Aldebaran and this companion appear in the catalogs as β550. I told you old Burnham was eagle-eyed!

The Hyades proper contain two wide, bright pairs that Struve placed in his first appendix. The first is $\theta^{1,2}$ Tauri (ΣI 10), located about two degrees west and slightly south of Aldebaran. Of magnitudes 3.4 and 3.8, the components are 5.5 minutes apart in a north-south orientation. The respective spectra are A7 and K0, so expect the slightly fainter member to exhibit a yellow or orange tint. A degree southeast of Aldebaran is $\sigma^{1,2}$ Tauri (ΣI 11). This pair is fainter (magnitudes 4.7 and 5.1) and wider (7′)

Star	R.A. (2000)	Dec.	Mag.	Sep.	P.A.	Year
OΣ82	4h 22.7m	+15° 03′	7.3, 8.5	1.4″	355°	1985
68	4h 25.5m	+17 °56′	4.2, 7.5	1.4″	333°	1958
Σ546	4h 27.0m	+19 °08′	7.9, 9.7	6.8″	184°	1954
Σ545	4h 27.7m	+18° 12′	6.9, 8.7	18.9″	58°	1924
$\theta^{1,2}$	4h 28.7m	+15° 52′	3.4, 3.8	337″	346°	1921
80	4h 30.1m	+15° 38′	5.7, 8.0	1.8″	19°	1985
Σ559	4h 33.5m	+18° 01′	6.9, 7.0	3.1″	277°	1968
Aldebaran	4h 35.9m	−16° 31′	0.9, 11.1, 13.4	122″, 30″	34°, 110°	1923
$\sigma^{1,2}$	4h 39.3m	+15° 55′	4.7, 5.1	431″	193°	1922

than $\theta^{1,2}$. Both double stars are best viewed with low power on a small scope — better yet, with binoculars.

In the same field with $\sigma^{1,2}$ Tau is another wide pair formed by the 5.5 magnitude stars 80 and 81 Tauri. 80 Tau is a close binary. The 8th-magnitude secondary is currently near its maximum possible separation of 1.8″ (position angle 18°). The two stars have an orbital period of about 190 years. 80 Tau is a bonafide member of the Struve double star catalog, bearing the designation Σ554.

Three "real" Struve pairs are found within 1½ degrees of ε Tauri. The easiest of the trio is Σ545, whose magnitude 6.9 and 8.7 components, separated by a comfortable 19″, are easy prey for a standard 60mm refractor. I fail to see the white and orange colors Webb ascribed to this pair, but perhaps I wasn't using enough aperture (I viewed it with a 3-inch reflector). Roughly midway between ε and Aldebaran is Σ559 — one of the prettiest double stars in Taurus. Here we have two near-twin 7th magnitude stars set 3″ apart — a striking sight!

Neither Σ545 nor Σ559 has exhibited noticeable orbital motion since their discovery over a century and half ago. Such is not the case with Σ546, which lies less than a half degree west of ε. While not setting any speed records, Σ546 has undergone a slight change in position angle since Struve's time. The 10th magnitude companion currently rests almost due south of the 8th magnitude main star. At a distance of 7″, it will not be an easy small scope target. View this pair with a magnification of at least 100x.

Struve's son, Otto, netted several new double stars in the Hyades during a survey conducted between 1839 and 1842. Since the "OΣ" pairs are the ones that the elder Struve missed, many are difficult for scopes of small to medium aperture. A welcome exception is OΣ82, situated one degree southeast of γ Tauri and a half degree east of 58 Tau. OΣ82 is a slow-moving binary system; its orbital period exceeds two centuries. Right now, the magnitude 7.3 and 8.5 components are about as far apart (1.4″ in p.a. 355°) as they can get. If seeing conditions are favorable, OΣ82 can be split with a good 4-inch scope.

Our final pair is a rather recent discovery. Kuiper 17, better known as 68 Tauri, was discovered less than 50 years ago. Then, the magnitude 4.2 and 7.5 stars were 1.3″ apart (p.a. 323°), not very different from their current configuration. It's the magnitude difference that makes resolving this pair such a challenge. Try a magnification of 250x or more on an absolutely still night. If this doesn't work, you can always settle on a 9th magnitude star that shares the proper motion of the main system. Look 77″ to the west to see this star.

* * *

DOUBLE TAKES: The Hyades isn't the only cluster containing double stars. As I pointed out in the January, 1980 issue of *DSM*, several choice pairs reside in the Pleiades. Occasionally, you'll come across an open star cluster dominated by a bright, centrally-located double. Last winter, Paul Brown of Goderich, Ontario sent a description of Σ737 (magnitudes 8.5 and 9, 10.7″ separation, 305° p.a.), which lies at the heart of M36 in Auriga. Paul observed the pair with an 8-inch SCT, but I had no trouble capturing it with a 3-inch reflector at 120x. See if you can spot Σ737, and while you're at it, look south to M47 in Puppis for the striking pair Σ1121 (magnitudes 7 and 7.5, 7.4″, 304°).

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Variable Stars

Playing Hard to Get: Winter's Variables

by David H. Levy

Ever had a budding relationship with someone go sour because you met too often at first?

It can happen with variable stars, too. A few too many observations can hurt your credibility. How often should you observe a variable star? It all depends. It depends on such factors as the nature of the star, the type of weather you typically get, and of course, your own perseverance.

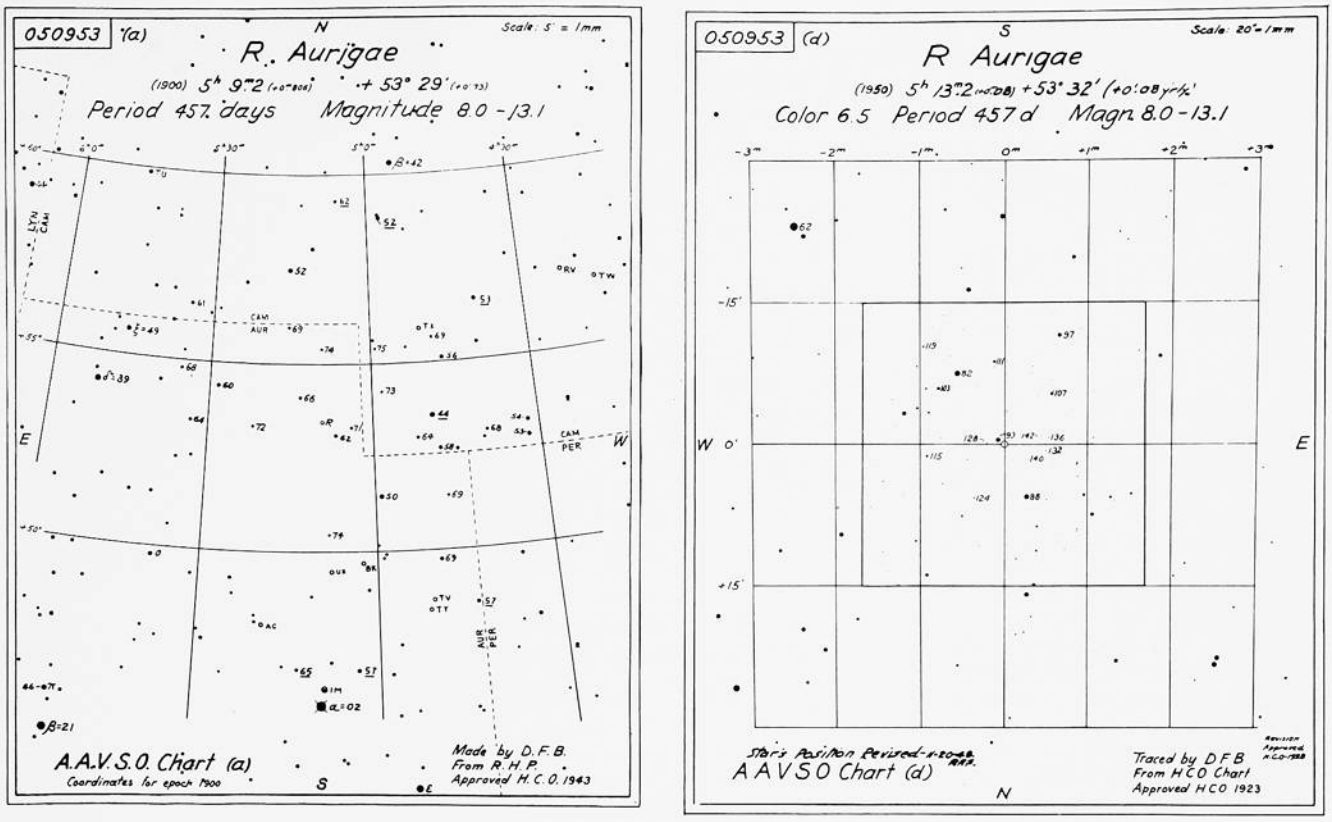
Let's begin with Mira-type stars, the long period variables with periods in the order of nine months to a year. Normally the recommended time is once every two weeks, but you can't be mindlessly mechanical about it. Look at the variable and what we know about its light curve — does it have sharp minima? If it does, then increase the frequency of observations to once every week — or even once every few days — during the month before minimum, returning to the fortnight cycle after the star has rounded the corner of minimum light and is well on the way back up.

Let's try one on for size — 050953 **R Aurigae** — the first variable discovered in Auriga. At 458 days, its period is very long and its light curve has nicely rounded maxima and minima. You needn't observe a star like this more often than twice a month and unless it's near a critical point of its curve, even once a month is fine. Since its smooth variation pattern is well established, you may wonder why you're observing it at all. The answer is that any single observation you make of R Aur isn't likely to shake the astronomical community to its roots, but it *is* desirable to keep a visual record of how a variable such as this behaves. For example, the curve could show anomalies, like an unexpected stop in the rising branch of the curve. If you happen to catch something like that, then it's your show.

Our second Mira is 043274 **X Camelopardalis**, a star with a much faster cycle of only 4½ months and a variation from 8.1 to 12.6. Things happen quickly with X Cam but, again, as long as the curve is steadily rising or falling, one observation per fortnight should suffice. When the star approaches a critical point like minimum or maximum, increase the observation frequency to once a week or — weather permitting — every five days. I would increase the rate when the star reaches 12th magnitude on its way down or 8.8 on its way up and keep looking intensively until you are satisfied that X Cam has turned the corner.

070122 **R Geminorum** is fun in three ways. First of all, its range of 7.1 to 13.5 is large so that if you catch it every two weeks, you should see a lot of changes

AAVSO#	Name	Period	Type	Range
050953	R Aurigae	458d	Mira	7.7-13.3
043274	X Camelopardalis	143d	Mira	8.1-12.6
070122	R Geminorum	370d	Mira	7.1-13.5
052372	RR Camelopardalis	124d	Semi-regular	9.6-11.3
054907	α Orionis	2070d	Semi-regular	0.4-1.3
072055	Y Lyncis	110d?	Semi-regular	7.2-7.8
074922	U Geminorum	102d?	U Gem	8.8-14.2



R Aurigae is a long-period (Mira-type) variable star with a period of a year and a quarter. The left chart covers when it is near maximum brightness, the right chart is for minimum light. (Note that north is up on the left chart, while the right one shows south up.) Charts reproduced by special permission from AAVSO director, Janet A. Mattei.

with each sighting. Second, its period of 370 days is so close to a year that you can almost tell when your birthday's coming round again by the magnitude it reaches as it rises or falls. Lastly, it's easy to find, being less than three degrees north and bit east from ξ Geminorum and about half a degree east from 6th-magnitude 44 Geminorum. Here is a star to enjoy — as long as you can forget the arctic temperatures under which you often are forced to observe it.

How often should we observe the semi-regular variables? Again, it depends. One of my favorites is 052372 **RR Camelopardalis**, a star with a range of slightly over a magnitude and a period of four months. Problem: small amplitude and not totally regular variation! When we look at the past behavior of a star like this, we see a picture of leisurely change in its variation pattern — nothing that happens overnight. Let's watch this one every two weeks.

And don't forget Alpha Orionis — yes, folks, this huge red giant is actually a bona fide variable we need to observe! Betelgeuse ranges from 0.4 to 1.3 with an alleged period of over five years, so estimating this star once a year would be fine, right? Wrong. Here is a star where semi-regular actually means something — I've seen variation over a couple of weeks! Apparently the main cycle has smaller, irregular periods lasting from a few weeks to several months superimposed on it. This star likes company every month, so indulge it. Just make sure you choose comparison stars that are close in altitude to the variable so that atmospheric extinction won't skew the results.

A difficult to watch semi-regular variable is 072055 **Y Lyncis**, which ranges from 7.2 to 7.8 in a highly uncertain period of 110 days. The range of half a magnitude is so slight that observing this star is problematical; observers may report magnitudes on a single night that cover more than the entire range of variation. (Actually, stars like Y Lyn — bright as they are — don't lend themselves to visual estimates.) If you decide to seek out the semi-regulars, try once a month only and always under the same conditions: no Moon, consistent city or country sky, and same binocular instrument. Watch out for the Purkinje effect in which red light builds up in your retina, causing an apparent though spurious increase in brightness. Be careful — but enjoy.

U Geminorum, 074922: the chart says it's irregular, and the guides announce that it is a "U Gem" or "SS Cyg" type. This means we're dealing with a close binary in which hydrogen transfers from one member to the other. When the smaller member gets more hydrogen than it knows what to do with, it simply lets go an explosion. With U Gem itself, the pattern of variation involves a few weeks of fairly constant activity at its minimum brightness of about 14th magnitude. The explosion sends the brightness climbing to its 8.9 maximum in anywhere from a few days to a *few hours* at intervals which are not very predictable. You have to be careful not to miss these exciting rises, so I recommend you check out U Gem once a night when it seems to be resting at minimum — and every hour if it is going into outburst.

Frequency of observation for your favorite variable is an important question. If you send in nightly observations of some Mira star, the astronomers studying your reports have to assume you have no understanding of the nature of the star. Do not observe Miras too often — it's simply a waste of good observing time. On the other hand, a set of observations over a single night for a U Gem star going into outburst provide real data.

So how often should you observe variables? As often as *they* want you to.

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Scanning the Literature

March - May 1985

by Brian Skiff

A second installment of a wide-ranging study of the Virgo cluster is presented by Allan Sandage, Bruno Binggeli, and Gustav A. Tammann in the March 1985 *Astronomical Journal* (*AJ*). Their paper, "Studies of the Virgo Cluster. IV. An Atlas of Virgo Cluster Spiral Galaxies: The Luminosity Range Within A Given Spiral Type" (**90**:395) is part of a planned six-paper series — though for reasons known only to themselves, the authors have deigned to publish only parts III and IV thus far.

Especially notable for visual observers and astrophotographers is their collection of 131 photographs showing spiral galaxies within 6° of the center of the Virgo cluster. The photographs, together with total magnitudes, display the range of brightness in each spiral type (Sa, Sb, Sc, etc.). The data confirm earlier suggestions that no dwarf spirals exist. The astronomers note the well-established "systematic progression toward fainter luminosities among later types and luminosity classes," but also point out the unexpectedly uniform mean brightness among types earlier than Sc. The distribution in each spiral type "bin" cuts off at both the bright ($M_B \sim -22$) and faint ($M_B \sim -17$) ends. There appear to be no well-organized spirals as faint as the Small Magellanic Cloud, for instance. The large atlas of photographs complements that published previously by the same group (see "Scanning" in DSM #9).

A useful batch of data on more distant galaxy clusters has been obtained by Harvye Hutcher and Augustus Oemler, Jr. in "The Evolution of Galaxies in Clusters. IV. Photometry of 10 Low-Redshift Clusters (*Astrophysical Journal Supplement Series* **57**:665, April). In the course of studying very distant galaxy clusters, the authors desired to compare their results with those on nearby clusters. They found the literature spotty in this respect, and as often happens when one seeks the answer to questions in astronomy, they had to go out to get the data themselves.

Plates from the Palomar 1.2-meter Schmidt were digitally scanned to produce magnitudes for many hundreds of galaxies in 10 clusters. The magnitudes are categorized on what's known as the JF system, which corresponds to the spectral responses of IIIa-J and IIIa-F emulsions used for the plates. The J-band magnitudes have an effective wavelength of about 5000 Angstroms in the green, near the peak visual dark adapted response, and thus correspond closely to true visual magnitudes. The F-band peaks at about 6500 Angstroms in the red.

Six of the clusters measured are good targets for amateur visual observing: Abell 262 (which includes NGCs 700, 705, 708, and others), A1367, the Coma (A1656) and Hercules (A2141) clusters, A2199 (centered on NGC 6166), and A2634 (including the 13th magnitude galaxy NGC 7720). Precise positions, magnitudes, colors, and identifications are listed for the galaxies, complete to J magnitude 17.5.

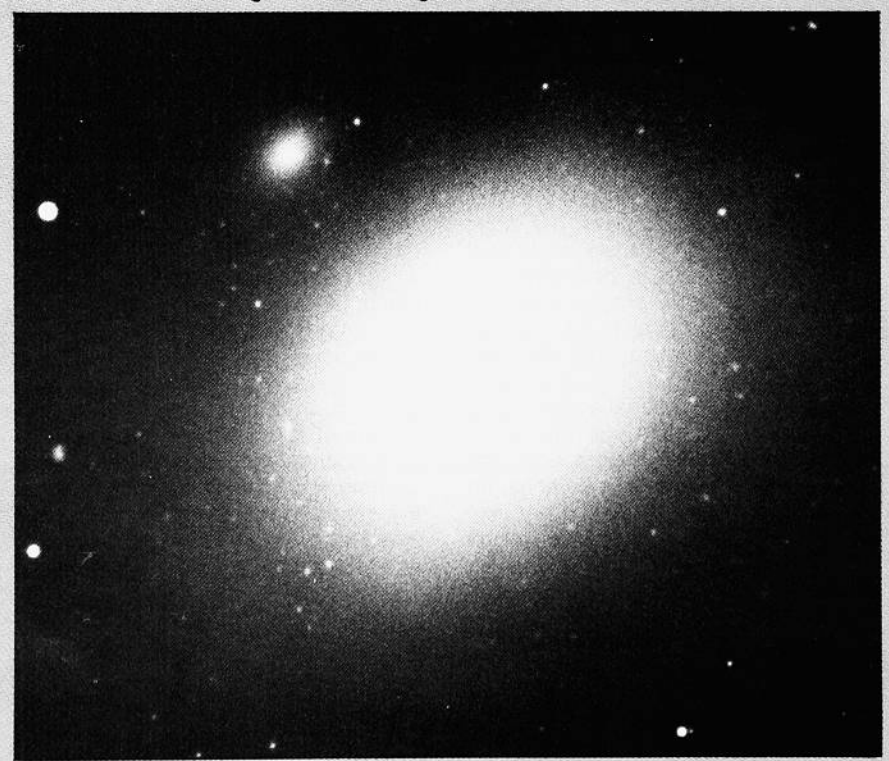
A field of extragalactic astronomy enjoying an active phase is the study of Seyfert galaxies. These are characterized by intensely bright stellar or substellar nuclei, often visible in amateur instruments. They were first described by Carl Seyfert, who noted unusual emission lines in spectra taken at Mount Wilson around 1940.

All Seyfert nuclei show strong, broad emission lines; the widths of the lines imply velocities in the excited gas of up to several thousand kilometers per second. The galaxies are divided into two broad categories based on these spectra. Type 1 Seyferts have broad lines of the Balmer series of hydrogen (Hα, Hβ, etc.), but rather narrower forbidden lines. In Type 2 Seyferts, the hydrogen and forbidden lines are about the same width but narrower overall than inType 1 Seyferts. Often the spectra are classified by simply comparing Hβ and the nearby forbidden oxygen lines (OIII). The Type 2 (OIII) lines are unusually strong, being typically 10 times stronger than Hβ, whereas Type 1 line ratios are all nearly the same.

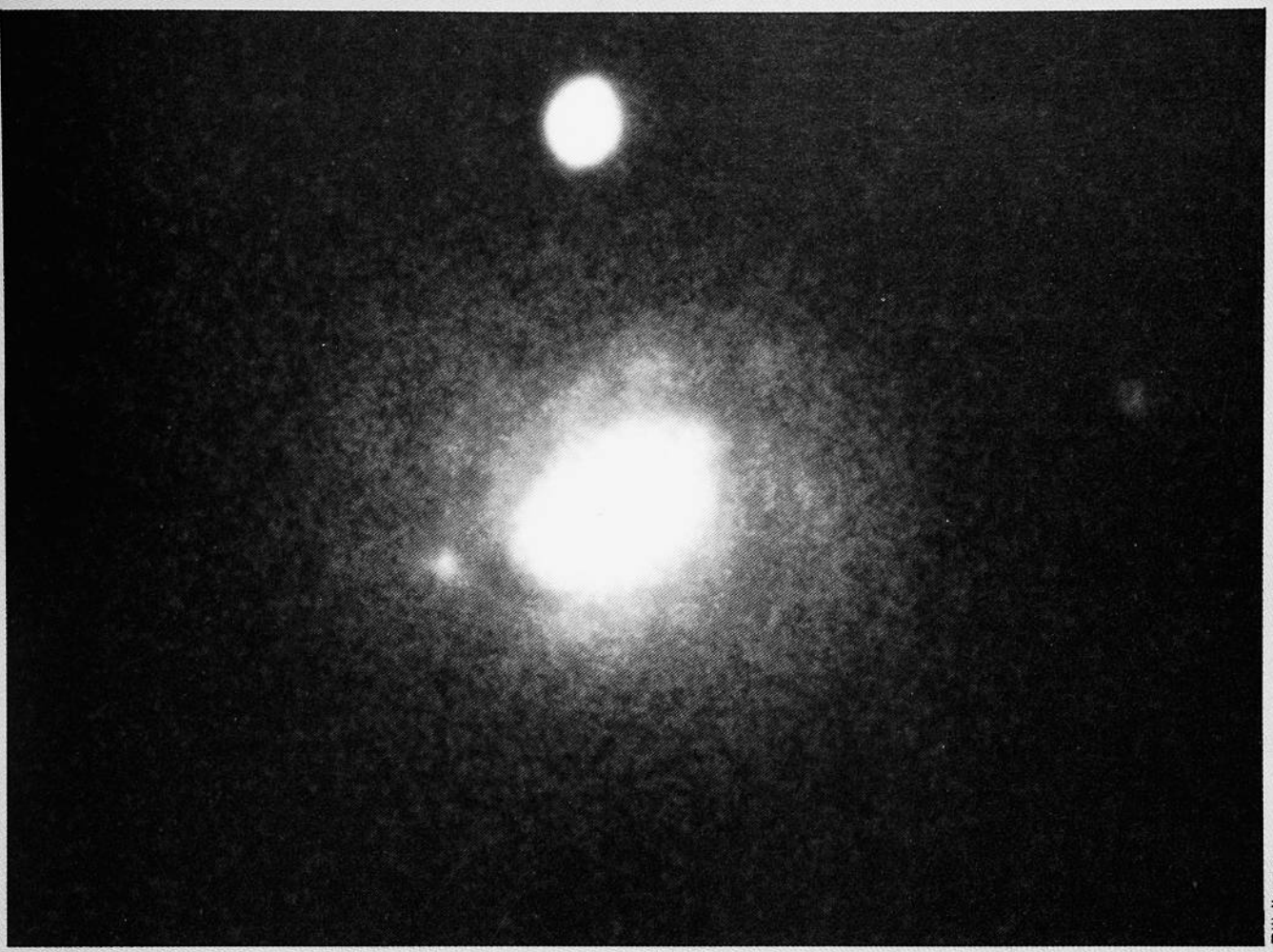
But these emission lines do not make up most of the energy released by Seyfert nuclei. In Seyfert 1 galaxies a nonthermal continuum radiation dominates instead. This arises in very strong magnetic fields in the nuclei through which ions from the gas producing the emission lines are moving. The luminosity generated by this mechanism is, in many cases, comparable to that of the least luminous quasars, whose spectra are remarkably similar to Seyferts and whose mode of energy generation seems to be the same.

A key link between Seyfert 1 nuclei and quasars is that both are variable in brightness. The short time scales of their variability imply that the radiation sources must be very small. Some new limits on the size of these sources are given by a group led by Brad Peterson and Karie Myers at Ohio State University in their paper, "The Variability of the Spectrum of Arakelian

M84 at the heart of the Virgo cluster: ***Sandage and Binggelli's study continues, providing a better look at this huge collection of galaxies.***



Palomar Observatory



Bill Iburg

Seyfert galaxy M77 in Cetus: *New research into Carl Seyfert's galaxies.*

120. II. Evidence for a Small Broad Line Emitting Region" (*Astrophysical Journal* (*ApJ*) **292**:164, May 1). Arakelian 120 is a luminous Seyfert 1 galaxy that is strongly variable both in overall brightness and in the strengths of its emission lines. The 14th magnitude object lies in Orion at 5h16.1m and −0°09′ (2000), and is known to vary over a range of two magnitudes.

A four-year program of spectroscopic and photometric monitoring of the galaxy reveals that the broad Hβ line changes on a time scale indistinguishable from the optical variability of the nucleus (dominated by nonthermal radiation). The astronomers conclude that the region of the nucleus containing the highly-excited gas must lie within about 30 light-*days* (0.026 parsecs) of the continuum source. This forces the energy source — nearly equal to that of a quasar — into a volume only 70 times the size of the solar system.

Having bridged the gap between quasars and Seyferts, it is natural to ask if there are objects whose properties lie between Seyferts and "normal" galaxies such as the Milky Way. A survey looking for such objects is presently being conducted by Alexei Filippenko and Wallace Sargent at Palomar Observatory. A first look at their data is given in "A Search for 'Dwarf' Seyfert 1 Nuclei. I. The Initial Data and Results" (*ApJ Supplements* **57**:303). Although there was some previous evidence these objects existed, this is the first survey based on observations of a large, unbiased sample of galaxies. It shows "dwarf" Seyfert 1 galaxies with broad but weak Hα lines and nonthermal continua are indeed present, and in numbers greater than heretofore expected.

One interesting facet of the study is that some mild Seyfert galaxies show variations in the strength of their emission lines much like their brighter cousins, the quasars. One such case is Messier 81, which was shown to have weak, broad Hα emission in its nucleus by the Mexican astronomers Manuel Peimbert and Silvia Torres-Peimbert in 1981. In 1984, the strength of its lines suddenly became several times stronger, as did its radio emission — M81 "turned on" a weak Seyfert nucleus!

David Turner's latest paper is "The Young Open Cluster Stock 16: An Example of Star Formation in an Elephant Trunk?" (*ApJ* **292**:148, May 1). UBV photometry, existing spectral classifications, and star counts were used to analyze the region around the cluster, which lies just east of the Coal Sack in the southern Milky Way. The cluster is embedded in an HII region known as RCW 75, which is involved in a prominent dust complex that extends further east. Turner's initial goal was to determine whether two nearby Wolf-Rayet stars and the Cepheid V378 Centauri were members of the cluster. If so, then an accurate assessment of the cluster's distance would help tie down the absolute magnitudes of these stars.

The UBV data indicate that the young, luminous open cluster is three to five million years old and lies about two kiloparsecs from Earth. The "nearby" stars, alas, are far in the background — nearly twice the cluster's distance from Earth. The star counts on photographs show that the cluster measures about 5′ in diameter, or 2.8 parsecs across. But they also possess an unusual pattern possibly due to an "elephant trunk" dark cloud terminating only 5′ southeast of the cluster. Turner notes that concentrations of faint stars along the edges of the cloud may represent newly-formed stars in an interactive region between the HII region and the dark cloud.

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Spiral Galaxy NGC-5364 in Virgo

Kitt Peak National Observatory photo